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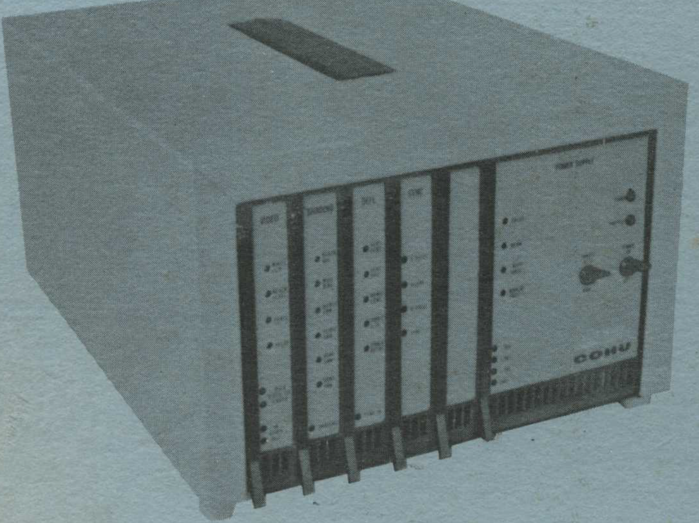


INSTALLATION, OPERATION, AND MAINTENANCE MANUAL FOR

MODEL 8000 CCU
AND
MODEL 8120 CAMERA

COHU
INC

Technical Manual
Code No. 6X-774

INSTALLATION, OPERATION, AND MAINTENANCE MANUAL
FOR
MODEL 8120 CAMERA
AND
MODEL 8000 CCU

September 13, 1982

COHU, INC., ELECTRONICS DIVISION
5725 Kearny Villa Road
Box 85623
San Diego, California 92138

WARNING

This equipment employs voltages that are dangerous. They can be fatal if contacted. Use extreme care when working on a unit having internal components exposed.

CAMERA AND CCU

TABLE OF CONTENTS

Section | Page

PART ONE – CAMERA

SECTION I
GENERAL DESCRIPTION

1.1 Electrical Characteristics 1-1
1.2 Mechanical Characteristics 1-1
1.3 Equipment Supplied 1-1
1.4 Equipment Required But Not Supplied 1-3
1.5 Optional Accessories 1-3

SECTION II
INSTALLATION

2.1 Receiving Inspection 2-1
2.2 Installation 2-1
2.3 Preparation for Shipment and Storage 2-3

SECTION III
OPERATION

3.1 Operating Procedures 3-1

SECTION IV
CIRCUIT DESCRIPTION

4.1 Image Tube Scanning 4-1
4.2 Deflection Board (A3). 4-1
4.3 Video Preamplifier Board (A4) 4-5

SECTION V
MAINTENANCE

5.1 Test Equipment Required 5-1
5.2 Cleaning and Lubricating. 5-2
5.3 Troubleshooting 5-2
5.4 Adjustments 5-2
5.5 Subassembly Removal, Repair and Replacement 5-11
5.6 Waveforms 5-14

SECTION VI
PARTS LISTS

SECTION VII
SCHEMATIC DIAGRAMS

TABLE OF CONTENTS

Section Page

PART TWO – CCU

SECTION VIII
GENERAL DESCRIPTION

8.1 Electrical Characteristics 8-1
8.2 Mechanical Characteristics 8-2
8.3 Equipment Supplied. 8-6
8.4 Equipment Required But Not Supplied 8-6
8.5 Optional Accessories 8-6

SECTION IX
INSTALLATION

9.1 Receiving Inspection 9-1
9.2 Installation 9-1
9.3 Preparation for Shipment and Storage 9-3

SECTION X
OPERATION

10.1 Operating Procedure. 10-1

SECTION XI
CIRCUIT DESCRIPTION

11.1 Video Board (A501) 11-1
11.2 Shading Board (A502) 11-7
11.3 Deflection Board (A503) 11-10
11.4 Sync Generator Board (A504-1) 11-13
11.5 Blanking Generator Board (A504-2). 11-19
11.6 Power Supply Assembly (A506) 11-22

SECTION XII
MAINTENANCE

12.1 Test Equipment Required 12-1
12.2 Cleaning and Lubrication 12-1
12.3 Troubleshooting 12-2
12.4 Performance Testing 12-2
12.5 Adjustments 12-2
12.6 Subassembly Removal, Repair and Replacement 12-24
12.7 Waveforms 12-25

SECTION XIII
PARTS LISTS

SECTION XIV
SCHEMATIC DIAGRAMS

CAMERA AND CCU

LIST OF ILLUSTRATIONS

Figure Page

PART ONE – CAMERA

1-1 Model 8120 Camera 1-0b
1-2 Typical Closed Circuit Television System 1-3
1-3 Camera Functional Diagram 1-4
1-4 Camera Critical Dimensions 1-5
1-5 Camera Model Number Interpretation 1-5
2-1 CCU Cable Interconnection Panel 2-2
3-1 CCU Operator Controls and Setup Adjustments 3-2
3-2 Typical Lens 3-2
4-1 Functional Diagram, Deflection Board (A3) 4-3
4-2 Functional Diagram, Video Preamplifier (A4) 4-5
5-1 Camera Deflection Board (A3) Adjustments 5-6
5-2 Lens Adapter Ring and Locking Setscrew 5-7
5-3 Test Setup, Gain and Bandwidth Adjustments 5-8
5-4 Video Preamplifier Board (A4) Adjustments 5-9
5-5 Camera Left Side Maintenance Features 5-10
5-6 Waveforms, Deflection Board (A3), Sheet 1 of 4 5-14
5-7 Waveforms, Video Preamplifier Board (A4) 5-17
6-1 Model 8120 Camera, Front View, Location of Components 6-2
6-2 Model 8120 Camera, Rear View, Location of Components 6-2
6-3 Model 8120 Camera, Top View, Location of Components 6-2
6-4 Model 8120 Camera, Bottom View, Location of Components 6-3
6-5 Model 8120 Camera, Right View, Location of Components 6-3
6-6 Model 8120 Camera, Left View, Location of Components 6-3
6-7 Type 8460031-001 Deflection Board (A3), Location of Components 6-6
6-8 Type 8460041-001 Video Preamplifier Board (A4), Location of Components 6-8
6-9 Type 8460051-001 Interconnect Board (A5), Location of Components 6-9
6-10 Type 8460025-001 Filter Board (A6), Location of Components 6-10
7-1 Type 8460031-001 Deflection Board (A3), Schematic Diagram 7-3
7-2 Type 8460041-001 Video Preamplifier Board (A4), Schematic Diagram 7-5
7-3 Model 8120 Camera, Schematic Diagram 7-7

PART TWO – CCU

8-1 Model 8000 Camera Control Unit 8-0b
8-2 CCU Functional Diagram 8-2
8-3 EIA RS-170 Specifications 8-3
8-4 EIA RS-330 Specifications 8-4
8-5 EIA RS-343-A Specifications 8-5
8-6 Critical Dimensions, Rack-mount 8-7
8-7 Critical Dimensions, Portable Cabinet 8-8

LIST OF ILLUSTRATIONS (Cont'd)

Figure Page

PART TWO – CCU

8-8 CCU Model Number Interpretation 8-9
9-1 CCU Cable Connections 9-2
9-2 Type CA-218 CCU-to-Camera Cable 9-3
9-3 Type CA-219 Superflex CCU-to Camera Cable. 9-4
9-4 Sync and Blanking Source, Multiple CCU/Camera System 9-5
10-1 Front Panel Operator Controls. 10-2
11-1 Functional Diagram, Video Board (A501) 11-2
11-2 Functional Diagram, Shading Board (A502). 11-7
11-3 Simplified Diagram, Shading Board (A502) 11-8
11-4 Functional Diagram, Deflection Board (A503). 11-11
11-5 Functional Diagram, Sync Generator Board (A504). 11-14
11-6 Horizontal-Timing Diagram 11-17
11-7 Vertical-Timing Diagram 11-18
11-8 Functional Diagram, Blanking Generator Board (A504-2) 11-20
11-9 Functional Diagram, Power Supply (A506) 11-24
12-1 Test Points and Adjustments, Power Supply Board (A506-A1) 12-8
12-2 Test Points and Adjustments, Sync Generator Board (A504-1) 12-9
12-3 Test Points and Adjustments, Blanking Generator Board (A504-2) 12-12
12-4 Test Points and Adjustments, Deflection Board (A503) 12-14
12-5 Composite Video Output Signal 12-16
12-6 Test Points and Adjustments, Video Board (A501) 12-16
12-7 Test Points and Adjustments, Shading Generator Board (A502) 12-21
12-8 Extender Board (A505) Features 12-25
12-9 Waveforms, Video Board (A501) (Sheet 1 of 2) 12-26
12-10 Waveforms, Shading Generator Board (A502) (Sheet 1 of 2) 12-28
12-11 Waveforms, Deflection Board (A503) (Sheet 1 of 4) 12-30
13-1 Model 8000 CCU, Front View, Location of Components 13-2
13-2 Model 8000 CCU, Rear View, Location of Components 13-3
13-3 Model 8000 CCU, Top View, Location of Components 13-3
13-4 Model 8000 CCU, Bottom View, Location of Components 13-4
13-5 Model 8000 CCU, Right View, Location of Components. 13-4
13-6 Model 8000 CCU, Left View, Location of Components 13-4
13-7 Type 8462205-001 Extender Board (A505), Location of Components 13-5
13-8 Type 8460601-001 Video Board (A501), Location of Components. 13-12
13-9 Type 8460611-008/-012/-016/-020/-032 Filter Board (A501A1), Location of Components 13-13
13-10 Type 8460701-001 Shading Board (A502), Location of Components 13-16
13-11 Type 8460401-001 Deflection Board (A503), Location of Components 13-19
13-12 Type 8460811-001 Sync Generator Board (A504-1), Location of Components . . 13-23
13-13 Type 8462001-001 Blanking Generator Board (A504-2), Location of Components. . . 13-26
13-14 Type 8460502-001 Power Supply Assembly (A506), Front View, Location of Components 13-27
13-15 Type 8460502-001 Power Supply Assembly (A506), Rear View, Location of Components 13-27
13-16 Type 8460502-001 Power Supply Assembly (A506), Top View, Location of Components 13-28

LIST OF ILLUSTRATIONS (Cont'd)

Figure Page

PART TWO – CCU

13-17 Type 8460502-001 Power Supply Assembly (A506), Bottom View, Location of Components 13-28
13-18 Type 8460502-001 Power Supply Assembly (A506), Right View, Location of Components 13-28
13-19 Type 8460502-001 Power Supply Assembly (A506), Left View, Location of Components 13-29
13-20 Type 8460501-001 Power Supply Board (A506A1), Location of Components 13-31
13-21 Type 84619121-001 Interconnection Board (A507), Location of Components 13-32
14-1 Type 8460601-001 Video Board (A501), Schematic Diagram (Sheet 1 of 3) 14-3
14-2 Type 8460611-008/-012/-016/-020/-032 Filter Board (A501-A1), Schematic Diagram . . 14-9
14-3 Type 8460701-001 Shading Board (A502), Schematic Diagram 14-11
14-4 Type 8460401-001 Deflection Board (A503), Schematic Diagram (Sheet 1 of 2) 14-13
14-5 Type 8460811-001 Sync Generator Board (A504-1), Schematic Diagram (Sheet 1 of 2). . 14-17
14-6 Type 8462001-001 Blanking Generator Board (A504-2), Schematic Diagram 14-21
14-7 Type 8460502-001 Power Supply Board (A506-A1), Schematic Diagram 14-23
14-8 Model 8000 CCU, Schematic Diagram 14-25

LIST OF TABLES

Table Page

PART ONE – CCU

1-1 Specifications (When equipped with a Cohu 8541A image tube) 1-2
3-1 Operator Controls and Adjustments. 3-1
4-1 Inputs and Outputs, Deflection Board (A3) 4-2
4-2 Inputs and Outputs, Video Preamplifier Board (A4). 4-5
5-1 Test Equipment Required 5-1
5-2 Troubleshooting 5-3
5-3 Internal Adjustments 5-5
6-1 Model 8120 Camera Parts List 6-2
6-2 Type 8460031-001 Deflection Board (A3) Parts List 6-4
6-3 Type 8460041-001 Video Preamplifier Board (A4) Parts List 6-7
6-4 Type 8460051-001 Interconnection Board (A5) Parts List 6-9
6-5 Type 8460025-001 Filter Board (A6) Parts List 6-10

PART TWO – CCU

8-1 Sync and Blanking Sources 8-9
10-1 Operator Controls and Adjustments. 10-1
11-1 Inputs and Outputs, Video Board (A501) 11-3

LIST OF TABLES (Cont'd)

Table | Page

PART TWO – CCU

11-2 Inputs and Outputs, Shading Board (A502) 11-8
11-3 Inputs and Outputs, Deflection Board (A503) 11-10
11-4 Inputs and Outputs, Sync Generator Board (A504-1) 11-13
11-5 Pulse Duration Verses Scan Rate 11-14
11-6 Inputs and Outputs, Blanking Generator Board (A504-2) 11-20
11-7 Inputs and Outputs, Power Supply Board (A506-A1) 11-23
12-1 Recommended Test Equipment 12-1
12-2 Troubleshooting 12-3
12-3 Video Board Adjustments 12-5
12-4 Shading Board Adjustments 12-5
12-5 Deflection Board Adjustments 12-6
12-6 Sync Generator Board Adjustments 12-6
12-7 Blanking Generator Board Adjustments 12-7
12-8 Power Supply Board Adjustments 12-7
12-9 Power Supply Voltage and Ripple Limits 12-8
12-10 Sync Generator Board Line Rate Selection 12-11
12-11 Shading Board Adjustments 12-22
13-1 8000 Series Camera Control Unit Parts List 13-2
13-2 Type 8460601-001 Video Board (A501) Parts List 13-6
13-3 Type 8460611-008/-012/-016/-020/-032 Filter Board (A501A1) Parts List 13-13
13-4 Type 8460701-001 Shading Board (A502) Parts List 13-14
13-5 Type 8460401-001 Deflection Board (A503) Parts List 13-17
13-6 Type 8460811-001 Sync Generator Board (A504-1) Parts List 13-20
13-7 Type 8462001-001 Blanking Generator Board (A504-2) Parts List 13-24
13-8 Type 8460502-001 Power Supply Assembly (A506) Parts List 13-27
13-9 Type 8460501-001 Power Supply Assembly (A506A1) Parts List 13-30
13-10 Type 8461921-001 Interconnect Board (A507) Parts List 13-32

PART ONE
CAMERA

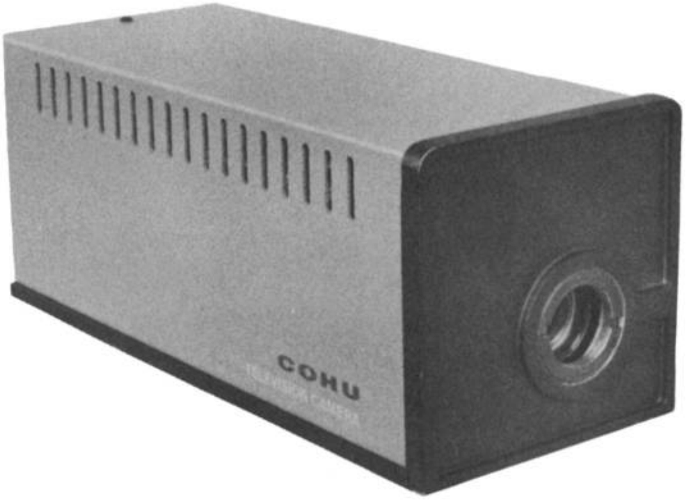


Figure 1-1. Model 8120 Camera

PART ONE – CAMERA

SECTION I
GENERAL DESCRIPTION

The Cohu model 8120 high-resolution monochrome television Camera (figure 1-1) is a compact unit designed for unattended, continuous duty closed-circuit television applications where the highest quality picture reproduction is required and limited space is available for installation. The Camera is capable of producing clear and crisp pictures with maximum detail information, superior corner resolution, and flatness of field, making it an ideal tool for inspection, measurements, microscopy and other medical, scientific, and industrial instrumentation uses. Its small size and light weight make it suitable for interfacing with microscopes and other delicate instruments.

The Camera operates in conjunction with an 8000 Series Camera Control Unit (CCU), which is described in part 2 of this manual. The CCU connects to the Camera with a single multiconductor cable. Without adversely affecting picture quality, the length of this cable may be up to 2000 feet with an 8 MHz bandwidth resolution. Within the broad limits specified in table 1-1, Camera performance is unaffected by extremes of temperature, humidity, vibration, shock, or dynamic pressure. A typical closed-circuit television system using this equipment is shown in figure 1-2.

1.1 ELECTRICAL CHARACTERISTICS

A low-noise FET-input video preamplifier provides high picture fidelity with maximum bandwidth and signal-to-noise ratio.

Full resolution of all 10 EIA shades of grey are rendered with 0.5 footcandle faceplate illumination.

With a Cohu 8541A image tube operating at 30 frames per second and 4:3 aspect ratio, optimum performance can be obtained with the Camera located up to 2000, 1000, or 500 feet from the CCU when operating with 8-, 16-, or 32-MHz bandwidths, respectively.

The dc filament voltage supply is regulated. Protection circuits are provided to prevent damage to the image tube in the event of either verticle- or horizontal-sweep failure. Circuits are factory set to provide a scanning pattern with an aspect ratio of 4:3, width to height. Other patterns can be set.

A wide range automatic sensitivity circuit controls the target voltage, video gain, dark-current compensation, and high-frequency response. These circuits, located at the CCU, are described in part II. Figure 1-3 shows a functional diagram of the Camera.

1.2 MECHANICAL CHARACTERISTICS

The Camera components are enclosed in a compact 4 x 4 x 10 inch rectangular aluminum housing with a scuff resistant finish. Refer to table 1-1 and figure 1-4 for specifications and critical dimensions. Installed on the front of the Camera is a C-mount lens adapter that accepts most types of 16-mm fixed focal length and zoom lenses. On the rear is a single receptacle for a multiconductor cable from the CCU. In the base are three threaded holes provided for mounting the Camera to a standard tripod, pedestal, pan-and-tilt unit, or other suitable mount.

1.3 EQUIPMENT SUPPLIED

Figure 1-5 is a model number interpretation of the 8120 Camera. Since all optional capabilities are part of the CCU, the Camera model number breakdown does not show any accessories.

1. Model 8120 Camera
2. Interconnect cable (a, b, c, or d)
    a. CA 218 Standard cable
    b. CA 218B Standard cable with right-angle connector at Camera

Table 1-1. Specifications (When equipped with a Cohu 8541A image tube)

ELECTRICAL

Input Voltage	105 –130/210 –260 V ac switched; 50 or 60 Hz
Input Power	60 W maximum
Vertical Sweep Rate	60 Hz; 50 Hz, with CCIR
Horizontal Sweep Rate	15,000 Hz to 37,000 Hz
Scanning	2:1 interlace at 405 to 1225 lines per frame, 25 or 30 frames per second; 4:1 interlace at 1227 to 1749 lines per frame, 15 frames per second
Synchronization	EIA RS-170/RS-343-A Specifications; or CCIR, jumper selectable
Image Pickup Tube Type	1-inch diameter, separate mesh, with magnetic deflection and focus; Cohu 8541A or equivalent
***Sensitivity**	Full p-p video is maintained with 0.5 lumen/ft^2 highlight illumination on image tube faceplate, and a usable picture is produced with only 0.05 lumen/ft^2
Resolution	Typical for cameras equipped with a Cohu 8541A vidicon at 30 frames per second, 4:3 aspect ratio:

Line Rate	Horizontal Resolution** 8 MHZ BW	16 MHz BW	32 MHz BW	Vertical Center Resolution**
525	650	1200	1400	340
675	525	1050	1400	425
729	500	950	1400	475
875	400	775	1400	575
945	350	675	1300	600
1023	325	625	1200	650
1125	300	550	1100	725
1225	250	500	1000	775

**Other line rates available

Signal-to-Noise Ratio (Visual Equivalent)	32 MHz, 30 dB; 16 MHz, 38 dB; 8 MHz, 41 dB
Automatic Black Level	Maintained by a keyed clamp, compensated for image tube dark current as a function of ambient temperature and target voltage
***Automatic Light Range**	Video output is maintained within 6 dB for variations in faceplate illumination from 0.1 footcandle to 1,000 footcandles
Resolution Stability vs. Temperature	Meets resolution specifications over range of –10° to 50° C (15° to 122° F)
Resolution Stability vs. Voltage Variation	Meets resolution specifications over input voltage range
Gamma Correction	0.5, 1.0, or 1.3, jumper selectable
***Gray Scale Rendition**	Renders all 10 shades of gray on EIA TV Resolution Chart, 1956, with 0.5 footcandle highlight illumination on the image tube faceplate
Signal Transmission Distance (With RG-11 foam cable)	Up to 2000 feet, 8 MHz bandwidth; up to 1000 feet, 16 MHz bandwidth; up to 500 feet, 32 MHz bandwidth
Output Video	Selectable 0.7 V or 1.5 V p-p non-composite, 1.0 V or 2.0 V p-p composite, with a load impedance of 75 ohms.
Geometric Distortion	Less than 1.5%
Scan Failure Protection	Automatic protection for both horizontal and/or vertical scan failure
Sync Input Signal	External 2.0 V to 8.0 V negative-going sync and blanking through two sets of BNC loop-through connectors. 1000+ ohms input impedance **OPTIONAL SYNC MODULE:** Master oscillator, crystal controlled or phase locked to ac power line frequency, jumper selectable
Vertical-Scan Frequency	Derived from same source as horizontal-scan frequency. Vertical-sync interval must contain serrations
Underscan/Overscan	Adjustable to ±10%

**All specifications with 2854° K (Incandescent illumination)*

ENVIRONMENTAL

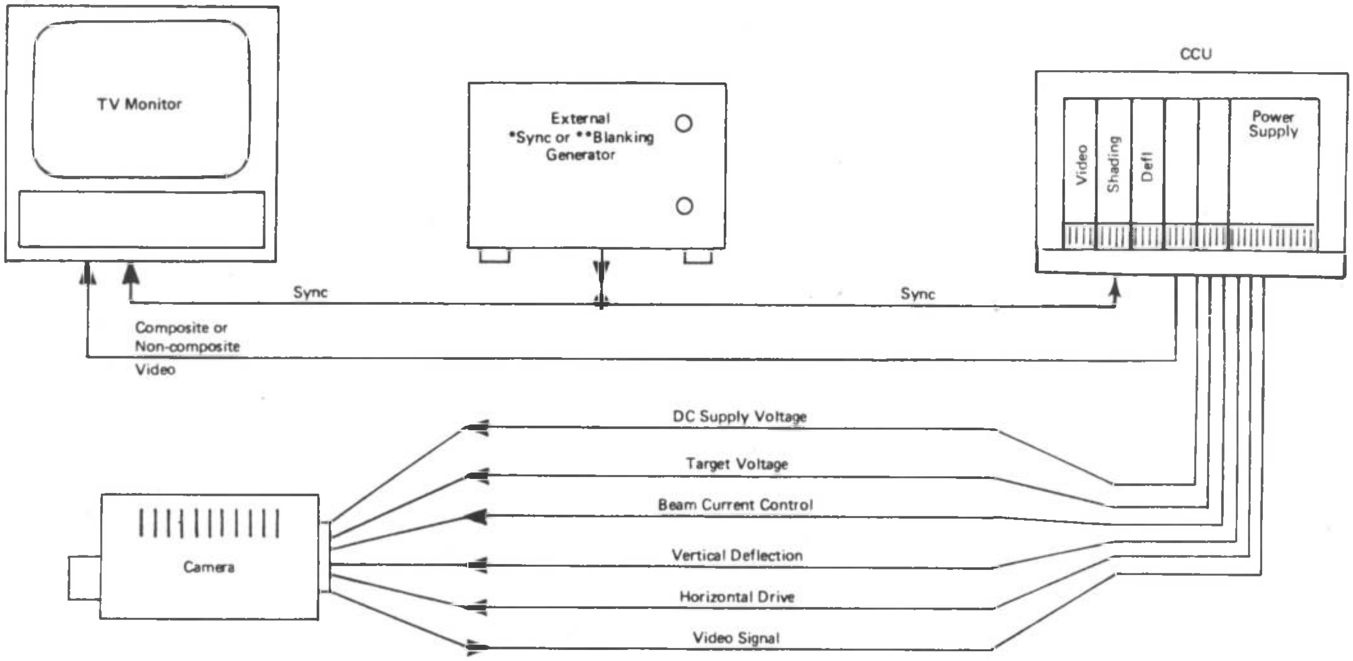
Ambient Temperature Limits:	
Operating	-20° to 50° C (-4° to 122° F)
Storage	-62° to 85° C (-79° to 184° F)
Altitude	Two atmospheres to 20,000 feet (609.6 m)
Humidity	90% noncondensing
Shock	Up to 15 g's in any axis under non-operating conditions, MIL-E-5400M, para. 3.2.24.6

MECHANICAL

Dimensions	See fig. 1-4, 8-6 and 8-7

UNIT	HEIGHT IN.	HEIGHT CM	WIDTH IN.	WIDTH CM	DEPTH IN.	DEPTH CM
Camera (less lens)	4.00	10.16	4.00	10.16	9.70	24.64
Control Unit						
Portable	6.45	16.38	10.15	25.78	13.20	33.53
Rackmount	5.25	13.33	19.00	48.26	12.00	30.48

Weight	**Camera:** 4 lb (1.8 kg), less lens **Portable CCU:** 20 lb (9.1 kg) **Single Rackmount CCU:** 20 lb (9.1kg) **Dual Rackmount CCU:** 39 lb (17.7 kg)
Type of Lens Mount	C-Mount, 16 millimeter format
Camera Mount	Three ¼-20 THD tapped holes; see dimensional drawing
Controls	Target, Beam, Focus, Gain, Black Level, Auto/Man Target Switch and Power On/Off Switch
Type of Connectors	Two BNC video output connectors. (Fig. 2-1). Two BNC external sync (In and Out) connectors. Two BNC external blanking (In and Out) connectors. One 37 pin AMP connector on CCU for single cable to one 37 pin AMP connector on the Camera



*Sync from an external source is required if camera control does not contain one of the optional sync generator plug-in units.

**Blanking from an external source is required if camera control does not contain either one of the optional sync generators or blanking generator plug-in units.

Figure 1-2. Typical Closed Circuit Television System

c.	CA 219	Superflex cable
d.	CA 219B	Superflex cable with right-angle connector at Camera

1.4 EQUIPMENT REQUIRED BUT NOT SUPPLIED

1. Lens
2. Camera Control Unit
3. Television Monitor

1.5 OPTIONAL ACCESSORIES

The following accessory items are likely to be required depending on the intended application.

1. Infrared sun filter
2. Pan and tilt unit
3. Tripod

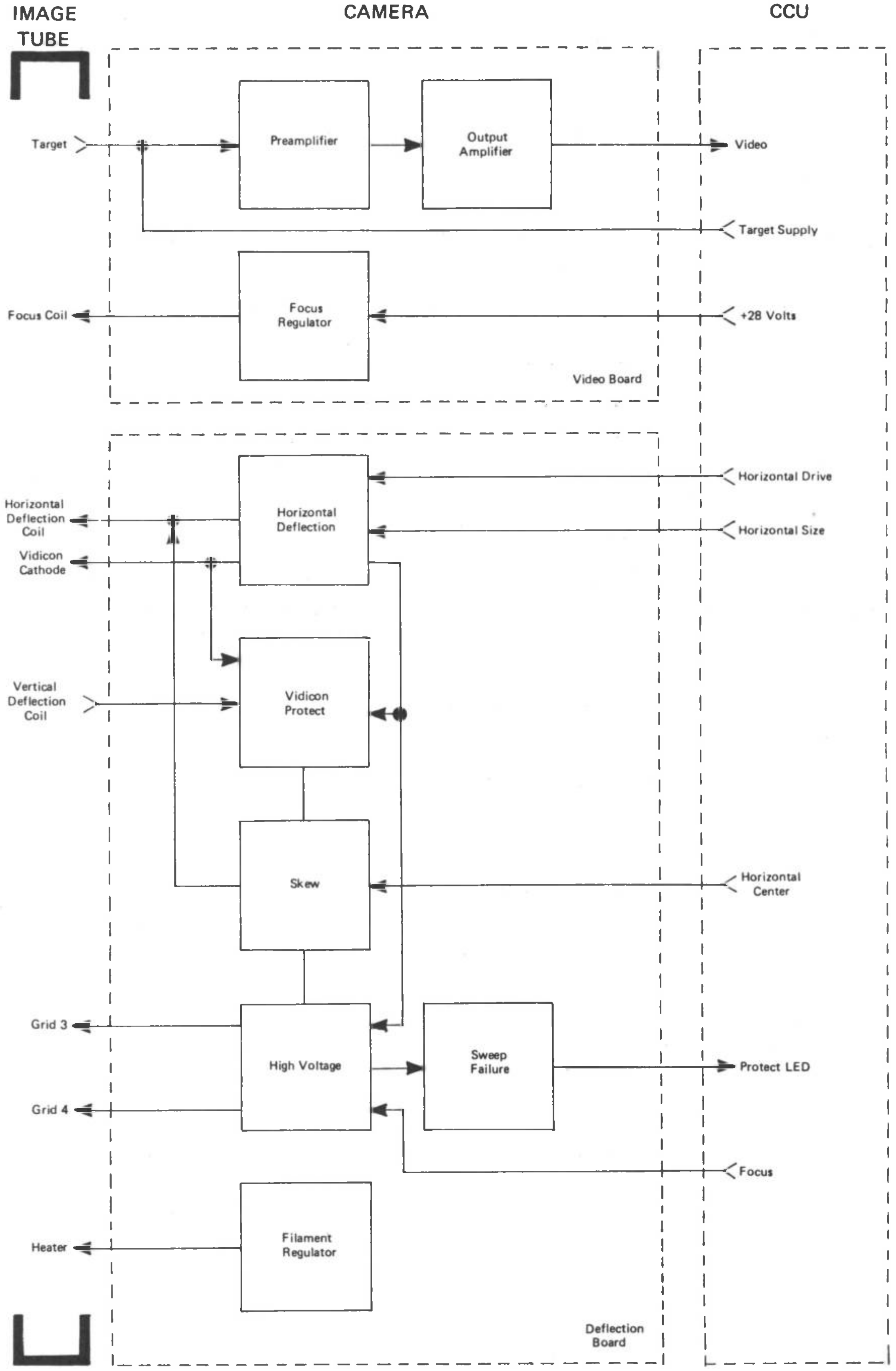
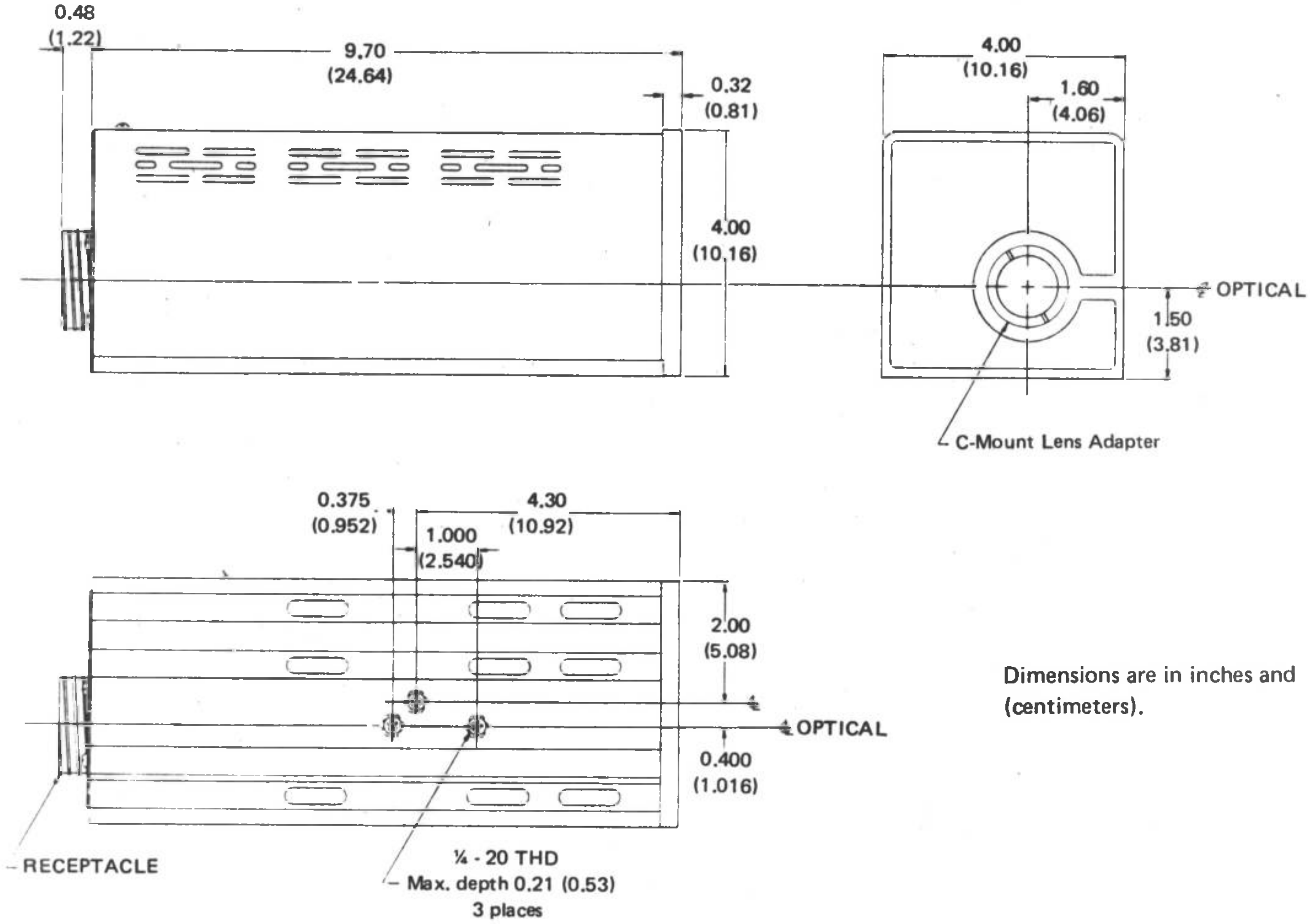


Figure 1-3. Camera Functional Diagram



Dimensions are in inches and (centimeters).

Figure 1-4. Camera Critical Dimensions

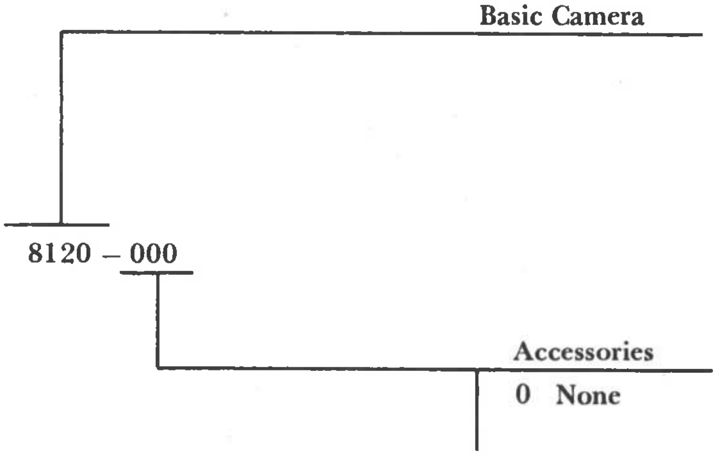


Figure 1-5. Camera Model Number Interpretation

PART ONE – CAMERA

SECTION II
INSTALLATION

2.1 RECEIVING INSPECTION

This item was thoroughly tested and carefully packed in our factory. Upon acceptance by the carrier, they assume responsibility for its safe arrival. Should you receive this item in a damaged condition, apparent or concealed, claim for damage must be made upon the carrier. Do not return the item to the factory, if required, until receiving an approval from our customer service department.

2.1.1 Apparent Damage

If upon receipt of this shipment a visual inspection shows damage, it must be noted on the freight bill or express receipt and the notation signed by the carrier's agent. Failure to do this will result in the carrier refusing to honor the claim. The carrier will furnish you with necessary forms for filing a claim.

2.1.2 Concealed Damage

When damage is not apparent until the unit is unpacked, a claim for concealed damage must be entered. When this damage is discovered, make a mail or phone request to the carrier for inspection. Keep all cartons and packing materials. You must make the request for inspection immediately upon discovery of concealed damage. Since damage is the carrier's responsibility, the carrier will furnish you with an inspection report and necessary forms for filing the concealed damage claim.

CAUTION

Before applying ac power to the CCU verify that the voltage range selection switch (115/230) is in the proper position for the line voltage to be used.

2.2 INSTALLATION

Camera installation is straightforward and should pose no particular problems. Before installing, plan the cable runs and provide for ac power to the CCU.

Installation consists of :

1. Mounting at the desired location
2. Making cable connection to the CCU
3. Installing an appropriate lens

2.2.1 Lens Installation

Cameras shipped from the factory without a lens have the threaded C-mount lens adapter ring plugged with a protective escutcheon button. The appropriate C-mount lens to screw into this adapter ring will depend on: field of view (height and width of the scene to be televised), distance from lens to subject, and intensity of illumination on subject.

Specialized applications may require other considerations. To install a lens proceed as follows:

1. Remove the plastic escutcheon button installed in the lens adapter opening.

2. Clean the face of the image tube and any dirty lens surface with a solution of 80% ethyl ether, 20% methyl alcohol and a soft lint-free optical lens tissue.

3. Screw the lens finger-tight into the adapter ring.

NOTE

A lens should always be fully threaded into the adapter ring to establish proper focus. When making adapter ring focusing adjustments the pair should turn as a unit.

4. Refer to section 5.4.2 for adjustment of the C-mount adapter to obtain proper mechanical focus after the Camera is operational.

2.2.2 Camera Mounting

Bolt the Camera to a suitable mounting surface, using the three threaded ¼-20 holes provided in the base of the Camera. Position the Camera on any angle and locate it anywhere that environmental conditions will remain within the limits specified in table 1-1.

2.2.3 Cable Connections

Camera-to-CCU cable connection consists of connecting the multiconductor cable from the CCU receptacle labled CAMERA (figure 2-1) to the receptacle (J1) located at the rear of the Camera (figure 6-2).

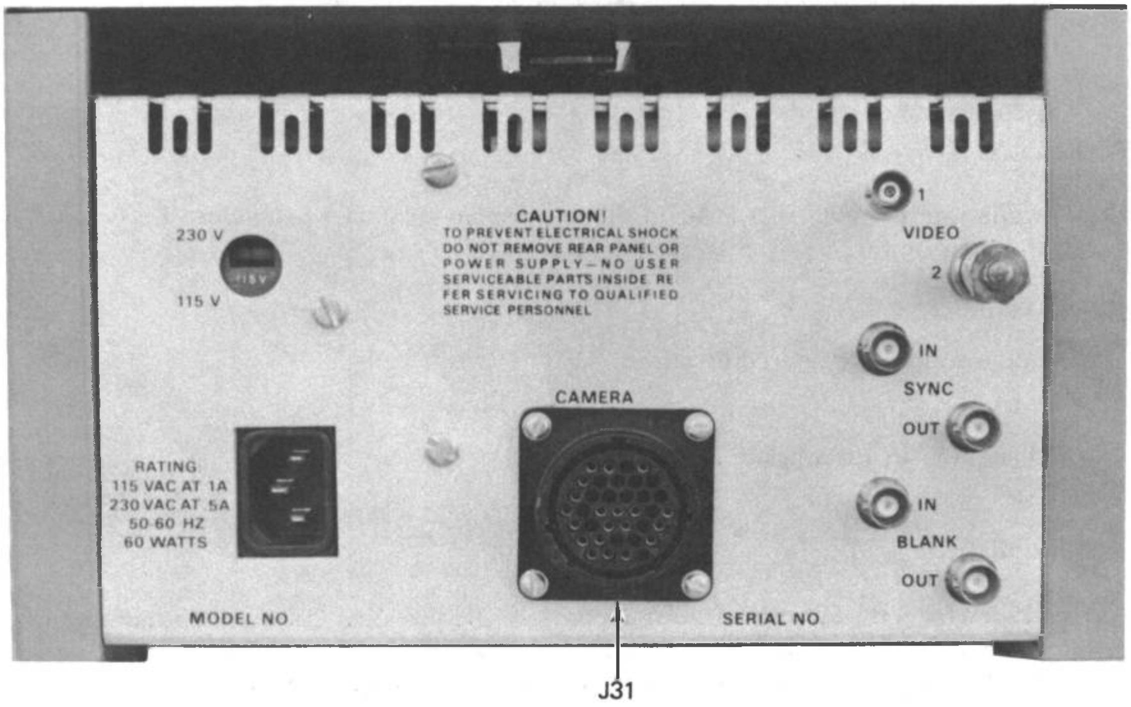


Figure 2-1. CCU Cable Interconnection Panel

2.3 PREPARATION FOR SHIPMENT AND STORAGE

For storage periods exceeding about a month, seal the unit in a vapor-proof bag containing a fresh desiccant pack prior to packaging the unit in a sturdy box. Use sufficient foam padding or other suitable packing material to prevent damage by sudden shock loads or crushing that may occur during shipping.

The storage environment must be maintained within –62° to +85° C, with relative humidity not exceeding 90 percent (without condensation).

SECTION III
OPERATION

Except for iris and focus adjustments on the imaging lens at the front of the Camera, all Camera functions are operated remotely from an 8000 Series CCU. Refer to part II of this manual for complete operating procedures.

Table 3-1 lists operator controls used when operating in the manual target mode. These controls, located on the front panel of the CCU, are shown in figure 3-1. They do not require special test equipment or tools for performing adjustments.

When it is necessary to televise a low-light scene follow the steps outlined in table 3-1.

Table 3-1. Operator Controls and Adjustments

NAME	OPERATION	FUNCTION
1. POWER ON/OFF	Set to OFF	Turns ac power off.
2. BEAM	Adjust fully ccw	Insures against tube damage when ac power is applied.
3. FOCUS	Adjust to midpoint	Rough electrical focus before ac power is applied.
4. MANUAL TARGET	Adjust fully ccw	Insures against tube damage when ac power is applied.
5. TARGET AUTO/MAN	Set to MAN	Selects manual control of light sensitivity of the Camera.
6. POWER ON/OFF	Set to ON	Turns ac power on.
7. Lens Iris	Fully open	Adjusts size of aperture to maximum.
8. BEAM	Adjust as needed until a "wiping-in" of light is seen on the tv monitor raster. Continue adjusting until light areas of the picture can be seen.	Adjusts beam current at Camera picture tube.
9. MANUAL TARGET	Adjust as needed to extinguish both VIDEO LVL indicator LEDs (OVER, UNDER), located on the front panel of the CCU.	Adjusts light sensitivity of the camera.
10. FOCUS	Adjust as needed for sharp picture on the tv screen.	Adjusts electrical focus of the scanning beam.

Repeat adjustments of the MANUAL TARGET, BEAM, FOCUS and iris to obtain the best possible picture and to extinguish both VIDEO LVL indicator LEDs (OVER/UNDER).

3.1 OPERATING PROCEDURES

1. Set up the Camera in a system as described in section II and section IX.
2. Aim the Camera at the scene to be televised and set the lens focus ring (figure 3-2) for the distance separating the Camera from the scene.
3. Select a lens aperture appropriate for the illumination on the scene (indoor scenes with average illumination usually will require settings from f/1.9 to f/3.5; outdoor scenes in daylight typically require settings from f/5.6 to f/22).

CAUTION

The image tube in a Camera can be irreversibly damaged by exposure to intense light. Be especially careful when the Camera is operated in low-light conditions, during which times the iris is usually fully open and the manual target mode is likely to be selected. An unanticipated source of light or increase in existing light could result in sufficient intensity to damage the tube.

4. On the CCU front panel, set the TARGET AUTO/MAN switch to AUTO.

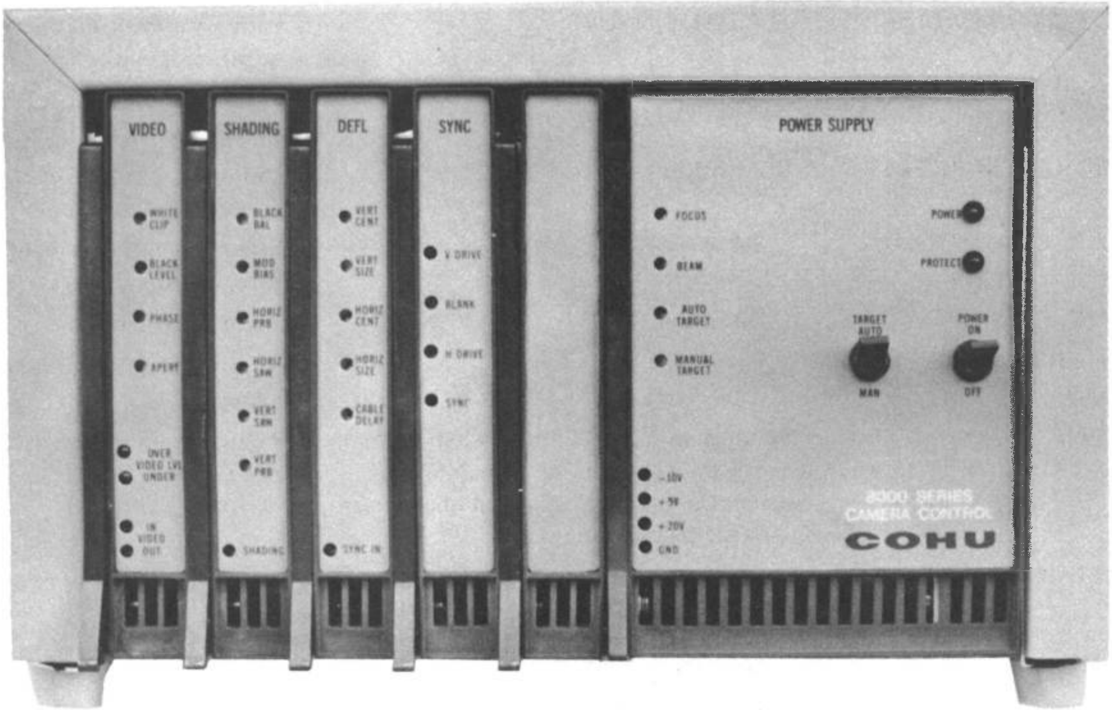


Figure 3-1. CCU Operator Controls and Setup Adjustments

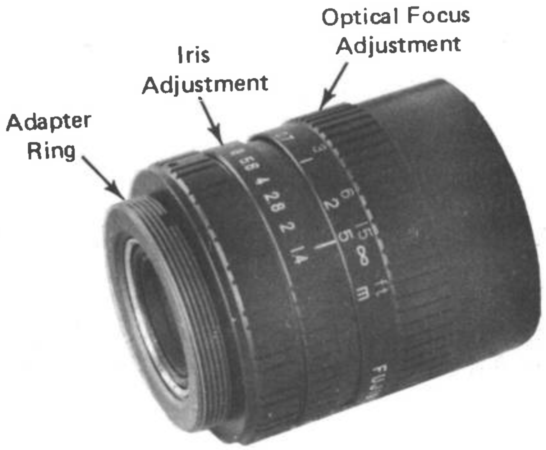


Figure 3-2. Typical Lens

5. On the CCU front panel, set the POWER switch to ON.

6. Readjust the focus ring on the lens for the sharpest possible picture.

7. Readjust the lens aperture, if necessary, to extinguish the VIDEO LVL OVER/UNDER LEDs located on the front panel of the CCU.

NOTE

If a newly installed lens cannot be properly focused with its adjustment ring, the C-mount lens adapter may have to be screwed in or out of the Camera slightly. The procedure for making this maintenance adjustment appears in section 5.4.2.

PART ONE – CAMERA

SECTION IV
CIRCUIT DESCRIPTION

A general overview of circuit descriptions is followed by detailed discussion of their operation. Circuit descriptions are divided into two sections: the deflection board (A3) and the preamplifier board (A4).

4.1 IMAGE TUBE SCANNING

An imaging lens at the front of the Camera initially focuses light from the scene being televised onto a photoconductive target located behind the faceplate of an image tube. This light induces on the target an electrical charge pattern that is proportional to the scene brightness. By replenishing the charge deficiences in this charge pattern, the light pattern is converted into a time sequence of current variations. Electrons from a beam scan the target to do this. They have a nominal amplitude of 300 nanoamperes peak-to-peak. At the video preamplifier section these current variations are converted into proportional voltage variations having a peak-to-peak amplitude of about 200 millivolts. In television terminology this voltage variation is called a video signal.

When the image tube in the Camera is a vidicon, the amplitude of the target signal current for a given light level is a function of a dc potential applied to the target. This tube characteristic allows Camera sensitivity to be adjusted manually or automatically with a gain control switch (TARGET AUTO/MAN) on the CCU).

Intensity of the electron scanning beam is a function of the dc potential on grid 1 of the image tube. This dc potential is adjustable with a BEAM control (also located on the CCU).

In preliminary setup, the BEAM control is adjusted so enough electrons are supplied by the beam to discharge the most highly illuminated areas of the target, but no more. Too little beam current causes a loss of detail contrast in the picture. Too much beam current reduces resolution and causes geometric distortion.

Any nonuniformity of the beam-landing angle at the target causes undesirable shading patterns in the picture. This is counteracted in the Camera by applying a dc potential of about +950 volts to grid 4 of the image tube. The resulting uniform decelerating electric field is introduced into the scanning beam path just before the beam reaches the target. This forces the beam into a near perfect trajectory to form a right angle to the target.

The electron beam scans the image tube target vertically at the established 50 to 60 Hz rate while simultaneously scanning it horizontally at a rate that can be in a range from 15 to 37 kHz, depending on internal selection. Beam deflection is accomplished with two alternating magnetic fields. These fields occur at right angles to each other and result from sawtooth waveforms in a horizontal-deflection coil and a vertical-deflection coil. The amplitudes of these sawtooth current waveforms control the height and width of the scanning pattern on the target and also the dc level about which the waveforms alternately position the scanning pattern vertically and horizontally on the target. Circuits that generate horizontal-deflection coil current and also the controls for adjusting its amplitude, linearity, and dc level are located on the deflection board (A3) in the Camera. Circuits generating and controlling dc level and amplitude of the current waveform in the vertical-deflection coil are located in the CCU.

The scanning beam is electrically focused so it converges to a point where it strikes the target. This is done with a focus coil by introducing a magnetic field parallel to the axis of the image tube. The dc current for this focus coil is supplied from an adjustable source located on the video preamplifier board. For the focusing field to function properly, a specific dc potential is required on grid 3 of the image tube. This potential is set with a FOCUS control located at the CCU.

4.2 DEFLECTION BOARD (A3)

The deflection board is located in the Camera (figure 6-7). Circuits on it (figure 7-1) include a horizontal deflection waveform generator, vidicon protection circuit, sweep failure indication circuit, high voltage supply and skew control. The descriptions are under corresponding headings in the following paragraphs.

Dc supply voltages and signals that enter or exit at the terminals of the deflection module are described in table 4-1. A functional diagram of circuits on the deflection board is shown in figure 4-1.

Table 4-1. Inputs and Outputs, Deflection Board (A3)

INPUT POWER	+20 V dc (terminal 3) +28 V dc (terminal 2) -10 V dc (terminal 4)
INPUT SIGNALS	
Horizontal Drive (terminal 112)	Positive-going, 4 V p-p pulse occurring at horizontal scan rate. Pulse width is about 3.6 μs.
Horizontal Size Control (terminal 12)	Adjustable dc potential in a range from 0 to +20 V
Vidicon Cathode (terminal 13)	Positive-going, 20 V mixed horizontal and vertical blanking pulses if Camera is operating normally. If a scan failure exists, the signal is a steady +20 V dc.
Vertical Deflection High (terminal 11)	Sawtooth current waveform that repeats at the established 50 to 60 Hz and has an amplitude of about 15 Vp-p
Focus Control (terminal 105)	Adjustable dc potential that falls in range from 0 to +20 V
Horizontal Centering (terminal 111)	Adjustable dc current
OUTPUT DC VOLTAGES	
G4 (terminal 7)	Adjustable potential set at +1060 V
G3 (terminal 8)	Adjustable potential set at +700 V
OUTPUT SIGNALS	
Protection Indicator (terminal 106)	About 5 V if Camera is operating normally. If a deflection failure exists, the signal is pulled to ground potential.
Horizontal Yoke Top (terminal 10)	Positive, 3 μs pulse that repeats at horizontal-scan rate and has an amplitude of approximately 75 V
G4 (terminal 7)	+1060 V dc or as otherwise set with R28
G3 (terminal 8)	+700 V dc or as otherwise set with R22
Filament (terminal 14)	Regulated 6.3 V dc

4.2.1 Horizontal Deflection

This circuit is formed with operational amplifier U51, transistors Q51 through Q54, and MOSFET Q55. It generates a pulse at the horizontal-scan rate that is applied to the horizontal-deflection coil. To develop this pulse, a negative-going, 4 V p-p horizontal-drive pulse that enters the board at terminal 112 is inverted and amplified by transistors Q51, Q52, and Q53. The amplified pulse drives MOSFET Q55. This FET supplies current for the horizontal-deflection coil, which conducts only while the scanning beam is tracing horizontally.

At the start of each horizontal retrace, the horizontal-drive pulse cuts Q55 off, stopping current flow through the horizontal-deflection coil, collapsing the magnetic field surrounding the coil. A ringing action originates in resonant network C53, C58, L52, L53, and the horizontal-deflection coil. This oscillation causes a high-speed reversal of current flow in the deflection coil, developing a magnetic field that deflects the scanning beam rapidly in the retrace direction. After the first half cycle of ringing, RC circuits R58-C59 and R64-C64 conduct to dampen out the oscillation. The resulting current waveform in the deflection coil is a sawtooth. This sawtooth has a ramp that is linearized with saturable reactor L52 and skew control circuit U71.

Amplitude of the sawtooth current waveform in the deflection coil establishes width of the scanning pattern on the image tube target. The amplitude is controlled with negative-feedback amplifier U51,

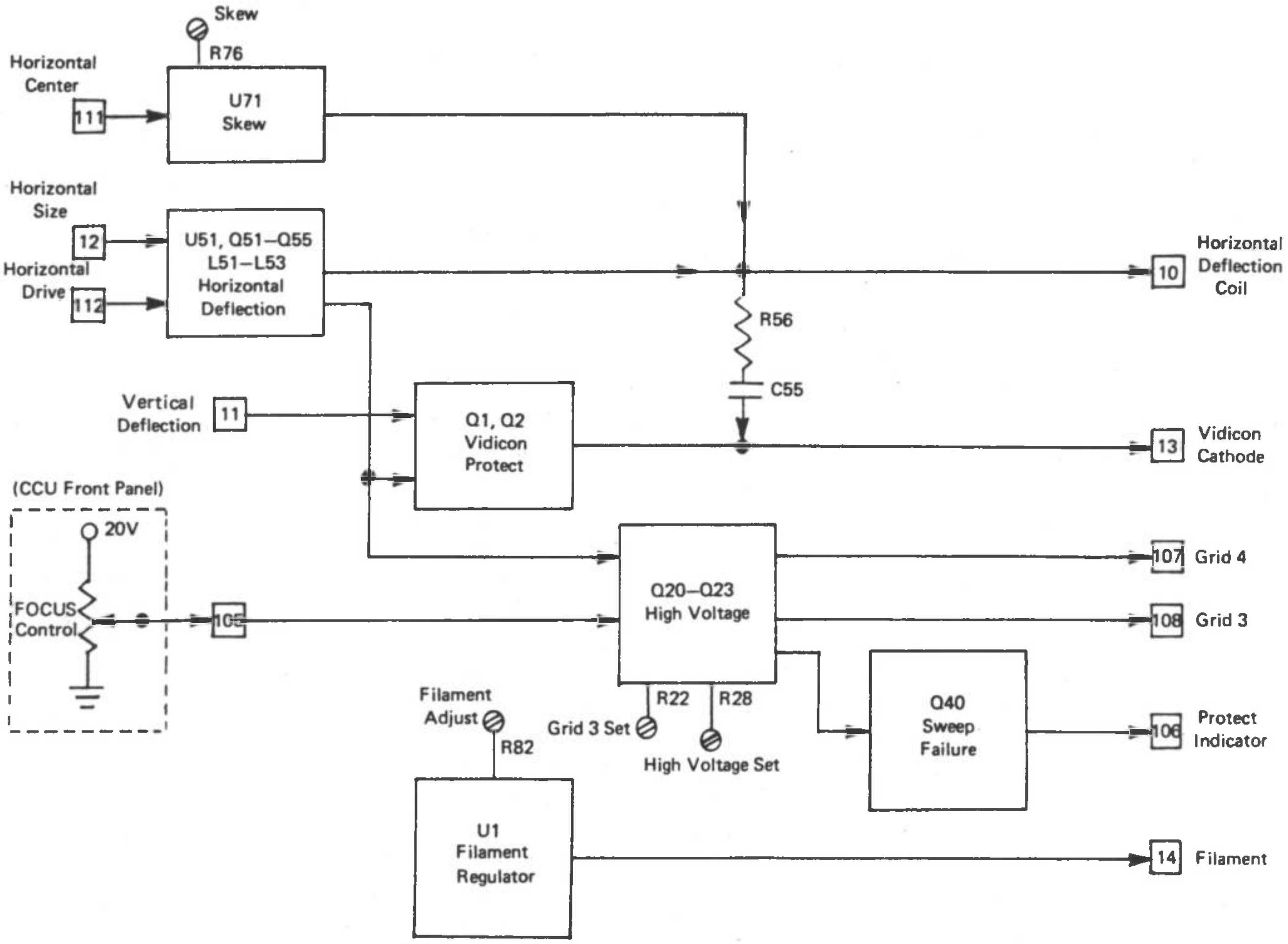


Figure 4-1. Functional Diagram, Deflection Board (A3)

Q54, and an adjustable dc voltage provided by the horizontal-size control, which enters the board on terminal 12. This dc voltage controls the gain of the amplifier. The sawtooth current waveform also establishes horizontal position of the scanning pattern. This is set through choke L51 and saturable reactor L52.

A flyback pulse is developed across the horizontal-deflection coil at the start of each retrace. This pulse is used to turn off the scanning beam at the image tube. It is coupled to the image tube cathode through R56 and C55.

4.2.2 Vidicon Protection

This circuit consists of transistor stages Q1 and Q2. When the scanning circuits are operating correctly, the circuit supplies to the cathode of the image tube a positive pulse to bias off the scanning beam at vertical-retrace times. If a vertical-deflection failure occurs, the circuit instead supplies a continuous positive dc potential that keeps the beam biased off until scanning is returned to the normal.

The circuit is driven at the base of Q1 with a sawtooth waveform that appears across the vertical-deflection coil. During vertical retrace times, the positive slope of this waveform biases Q1 off. At the same time, Q2 is biased off with a positive charge developed on C2 by current flow in CR1. Also, the collector of Q2 is grounded due to CR2 being forward biased with a negative potential coupled through R6. This collector potential at Q2 grounds the cathode of the image tube to turn on the scanning beam. At the start of vertical retrace, or if a vertical-deflection failure exists, the negative peak of the vertical-deflection coil waveform, or its absence, causes both Q1 and Q2 to switch to their conducting states, thus driving the collector of Q2 to approximately the same potential as the emitter, which is tied to the +20 volt bus. This +20 volts on the Q2 collector biases off the scanning beam. If this action was caused by a vertical-deflection failure, Q2 will stay biased on through R5, and C3 then will charge up via R7 to the Q2 collector potential to disable the high voltage supply and remove the high voltages from grids 3 and 4 of the image tube.

During the horizontal-retrace period, a positive pulse is applied through C55 from the horizontal-deflection waveform generator. This pulse forward biases diode CR3 to clamp the cathode of the image tube to +20 volts. In the case of a horizontal-deflection failure, the positive pulse from the horizontal-deflection waveform generator will not appear. There then will be no drive for the high-voltage supply, and the high-voltage potentials which the supply develops will be removed from grids 3 and 4 of the image tube.

4.2.3 Regulated High Voltage Supply

This supply, formed with transistors Q20 through Q23, develops the two high-voltage dc potentials that are applied to grids G3 and G4 of the image tube. It also generates the current supplied as input to the deflection failure indicator LED control circuit.

At the circuit input, a positive pulse is applied through capacitor C20 to the base of Q20. This pulse repeats at the horizontal-scan rate and originates at the horizontal-deflection circuit (section 4.2.1). At Q20 the pulse is shaped and reversed in polarity to provide a negative-going pulse with a fast-falling leading edge for the base of Q21. A diode (CR20) at the base of Q21 clamps the negative peak of the pulse to about 0.6 volts above ground, which with C22 keeps Q21 biased on between pulses. Whenever the pulse appears at the base of Q21, the transistor stops conducting, and a large, positive flyback pulse develops across the secondary of autotransformer T20. The negative excursion of this flyback pulse is damped out with diode CR21 to prevent ringing.

The flyback pulse that appears across the secondary winding of T20 is rectified by CR22 and filtered by C23 to provide a smooth +1060 V for accelerating grid (G4) of the image tube. The +1060 V is stepped down through a resistive divider to provide +700 V at the wiper arm of R22, which routes the +700 V to grid G3 of the image tube. Both the +1060 V and the +700 V are adjustable simultaneously with R28 (or with the FOCUS control located at the CCU). Both voltages are regulated by comparing the voltage at the junction of R23 and R25 with the regulated -10 V supply. Any change in the difference in potential between the two is amplified by Q22 and used to control the bias on Q23, a series-pass transistor that provides the collector voltage for power stage Q21.

If a horizontal-deflection failure occurs, a drive pulse no longer is supplied by the horizontal-deflection circuit to the base of Q20. The high-voltage supply then becomes inoperative to remove the +1060 V and +700 V from its output terminals. Also, the dc potential from Q23 provided as input signal for the LED deflection failure indicator driver (Q40) rises from a normal +20 volts. These circuit actions also occur if a vertical-deflection failure happens. In this case, the dc potential provided by the supply to the deflection failure indicator lamp control circuit through R41 switches from about -0.6 volt to about +20 volts to hold Q40 in saturation.

4.2.4 Deflection Failure Indicator Lamp Control

This circuit consists of transistor Q40 and resistors R41 and R42. If a horizontal- or vertical-deflection failure occurs, the circuit switches on a deflection failure indication lamp located at the CCU.

While the deflection circuits are functioning normally, transistor Q40 is biased off through R42. The potential at the collector of Q40 is then sufficient to keep the deflection failure indicator LED off. On occurrence of a horizontal- or a vertical-deflection failure, the high-voltage supply becomes disabled, and the dc potential it supplies through R41 rises to a positive level that biases Q40 on. When Q40 conducts, its collector is pulled to ground, providing a current path to light the PROTECT LED located on the front panel of the CCU.

4.2.5 Skew

Operational amplifier U71 provides horizontal-deflection circuit correction to make vertical lines more truly perpendicular to horizontal lines. Dc current is supplied to U71-2 from the horizontal-center control circuit, described in section 11.3.7. Potentiometer R76, provides for adjustment of the current out of pin U71-3. The output current is applied to the horizontal-deflection circuit through choke L51.

4.3 VIDEO PREAMPLIFIER BOARD (A4)

Circuits on the video preamplifier board include a video preamplifier, a video output amplifier, and a focus current regulator. Figure 4-2 is the functional diagram for these circuits, figure 7-2 is the schematic diagram, and table 4-2 the listing of input and output signals and voltages.

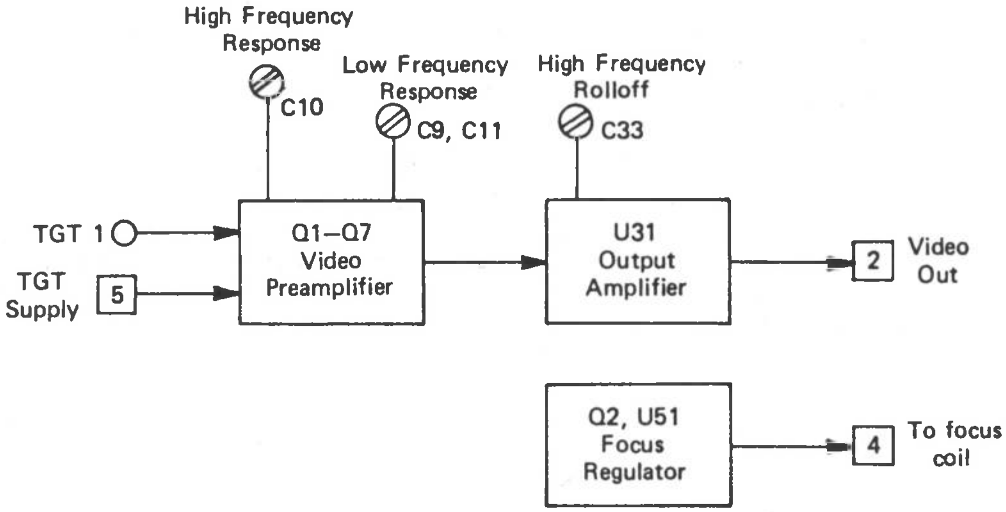


Figure 4-2. Functional Diagram, Video Preamplifier (A4)

Table 4-2. Inputs and Outputs, Video Preamplifier Board (A4)

INPUT POWER	+28 V dc (terminal 6) +20 V dc (terminal 8) -10 V dc (terminal 7)	
INPUT SIGNALS	**Target Current (TGT terminal)**	Nominal 300 nA p-p
	Target Supply (terminal 5)	Variable dc potential in range from about +5 to +60 volts
OUTPUT SIGNALS	**Video (terminal 2)**	200 mA p-p
	Focus Current (terminal 4)	Nominal 80 mA dc

This board converts image tube current signal into a voltage signal and then amplifies it. The board also produces a regulated dc current for the image-tube focus coil.

4.3.1 Video Preamplifier

Resistor R1 and R2 control the dc potential supplied from the CCU for target voltage of the image tube. The target voltage enables the scanning beam to generate a signal current that varies with scene illumination in the range from zero to about 300 nA p-p. In the video preamplifier module this current is converted into a video voltage signal by a negative-feedback low-noise wideband operational amplifier formed with transistors Q1 through Q7. The frequency response of the bandwidth is adjusted with C9 through C11. These capacitors are set so amplifier gain is flat within ±3 dB from 0 to 32 MHz.

4.3.2 Video Output Amplifier

The video signal that appears at the output of the video preamplifier (at TP1) has a nominal amplitude of 170 mV p-p when the target current is 300 nA p-p. This video signal drives an operational amplifier, U31, having a gain that is controlled with negative feedback through C33, C38 (high frequency rolloff), and R33.

4.3.3 Focus Current Regulator

The focus regulator section of the video preamplifier module is formed with adjustable shunt regulator U51 and power transistor Q2. Located on the Camera chassis for improved heat dissipation, the transistor operates as a series-pass stage for the dc current supplied to the image tube focus coil. This same current flows through R51, where it develops a feedback signal that is compared at U51. Any change in the normal level of focus coil current is compensated for by U51, which changes the base current on Q2 by the amount required to maintain a constant current in the focus coil.

PART ONE – CAMERA

SECTION V
MAINTENANCE

This section of the manual is intended for use only by technically qualified service personnel. These internal alignment and troubleshooting procedures are provided to maintain a camera at optimum performance. Only technicians familiar with television camera maintenance should attempt these procedures. The customer service department of Cohu, Inc., Electronics Division, should be contacted if it is felt that assistance is needed in maintaining the Camera.

5.1 TEST EQUIPMENT REQUIRED

Table 5-1 lists the equipment needed for testing and adjusting the Camera. The required characteristics given are not necessarily those of the equipment recommended. They reflect the capabilities necessary to measure voltage, resistance, and other characteristics of the circuits to the required accuracy.

The recommended equipment models are listed because of their extensive use (and resulting wide familiarity) in the industry. Similar equipment can be substituted for these items by those familiar with test equipment capabilities and limitations. The resolution and linearity charts at the rear of this manual can be substituted for the test jig; however, information on these charts, especially 1600-line resolution, may not be entirely accurate due to possible paper shrinkage and printing limitations.

Table 5-1. Test Equipment Required

EQUIPMENT REQUIRED	REQUIRED CHARACTERISTICS	RECOMMENDED EQUIPMENT
Oscilloscope	50 MHz Bandwidth	Tektronix Model 455
Sweep-Frequency Generator	50 or 75 Ω output 0.1 to 32 MHz Flat within ±0.5 dB	Hewlett-Packard Model 8601A
Voltmeter	0 to 30 V dc, floating 105–260 V ac ±2% accuracy	Hewlett-Packard Model 3476A/B
Voltmeter, High Impedance	100 kΩ/V impedance 650 to 1500 V dc ±2% accuracy	Data Precision Model 1350
Spectrum Analyzer	1 KHz to 50 MHz	Hewlett-Packard Model 8553B
Dot Bar Generator	525 to 1225-line linearity testing capability	Cohu 2380 Series
TV Monitor	High Resolution	Cohu DM Series
Vidicon Simulator	Must match 75 ohm signal generator output to the high impedance of an image tube target circuit	Cohu Model VS-2
Camera Test Jig	Must support Camera in a fixed position and provide backlighted 1600-line tv resolution chart and tv linearity chart. If used for adapter ring adjustment must have collimator lens	Cohu Model CTJ-2

5.2 CLEANING AND LUBRICATING

Interior circuit areas of the Camera, exposed glass surfaces on the lens, and the faceplate on the image tube should be cleaned periodically to remove accumulated dust and film. To reach the vidicon faceplate and circuit areas, the Camera cover must be removed from the chassis. This procedure is in paragraph 5.5.1. No lubrication is required for the Camera.

5.2.1 Circuit Board Cleaning

Clean circuit areas with a soft bristle brush and low-pressure air stream. Remove film buildup from the card-edge connector contacts with a soft tissue moistened with 1, 1, 1-trichloroethane.

5.2.2 Lens and Image Tube Cleaning

To remove dust and film buildup from glass surfaces on the lens and from the faceplate of the image tube, use an optical lens tissue moistenend with a solution of 80% ethyl ether, 20% methyl alcohol or some other optical lens cleaner. Never rub with dry tissue.

5.3 TROUBLESHOOTING

Troubleshooting procedures appear in table 5-2. In addition to those procedures, the following should be considered:

1. Always verify correct power input on the CCU and check for a blown fuse in the Camera filament circuit as the first step in troubleshooting a completely inoperative Camera.

2. When it is necessary to jumper a component to V_{DD} or V_{CC}, always use a 1.8-kilohm current limiting resistor to prevent accidental damage to the component.

5.4 ADJUSTMENTS

Adjustments for the Camera target voltage, video bandwidth gain, picture size and centering, and scan linearity are given in the following paragraphs. Any adjustments that are made must be performed with the Camera operating in a system with a CCU and a tv monitor known to be in good adjustment. Always allow 15 to 30 minutes for equipment warm-up before performing any of the adjustment procedures. Table 5-3 lists internal adjustment controls, their function as well as board location. For component and test point locations, refer to section VI. Schematic diagrams are in section VII.

WARNING

Up to 1100 V dc is exposed when the Camera is operated with its cover removed.

5.4.1 Deflection Board Voltage Adjustments

To adjust the Camera high voltage supplies (G3 and G4) and filament voltage on the deflection board proceed as follows:

1. Remove the cover from the Camera as described in section 5.5.1.

Table 5-2. Troubleshooting

SYMPTOM	PROBABLE CAUSE	ISOLATION PROCEDURE
No picture at the tv monitor	Beam not scanning target at the image tube	Check the setting of the BEAM current control (R30) on the CCU front panel.
	High voltage absent or incorrect at focus and field-mesh grids (G3 and G4) of the image tube	Check setting of the high voltage adjust (R22 and R28) and the high voltage circuit Q20–Q23 and T20 on the deflection board (A3).
	Target voltage too low at the image tube	Check the setting of target voltage control on the CCU.
	No filament voltage or filament burned out at the image tube	Verify 6.3 V dc between pins 1 and 8 at tube socket. If voltage is present and filament is not glowing, check continuity of the tube filament.
	Poor cable connection or open circuit in the cable	Check for bad connections at Camera-to-CCU receptacles. Also check wires in cable for continuity.
	Defective video amplifier stage	Check video preamplifier (A4), Q1–Q5.
Faint picture or poor contrast between blacks and whites	Insufficient video gain	If the gain is being controlled automatically, check the setting of AUTO TARGET (R52) on the CCU. Check the target circuit (Q1 and U2) on the CCU power supply.
		If the gain is being controlled manually, check the setting of MANUAL TARGET (R61).
		Enlarge the iris opening.
	Incorrect amplification of video signal	Check the video preamplifier (A4) Q1–Q5.
	Incorrect bias on image tube cathode	Check the horizontal deflection circuit Q51–Q55 and U51.
	Weak image tube	Replace the image tube (V1).
Snowy picture	Defective video amplifier stage	Check the video preamplifier Q1–Q5 and the output amplifier (U31) on the video preamplifier board (A3).
Poor contrast between black and white and some snow is present in the picture	Inadequate scene lighting	Increase the scene illumination
Picture not completely filled out from top to bottom on video monitor	Vertical deflection signal amplitude too low	Check the setting of VERT SIZE (R70) on the deflection board (A503) at the CCU.
	Defective deflection coil	Check for open circuit or shorted turns in the vertical winding of the deflection coil assembly (L1).

Table 5-2. Troubleshooting (Cont'd)

SYMPTOM	PROBABLE CAUSE	ISOLATION PROCEDURE
Picture not centered	Horizontal or vertical centering control out of adjustment	Check the setting of HORIZ CENT (R52) VERT CENT (R67) controls on and the deflection board (A503) at the CCU.
Picture compressed at top	Horizontal deflection waveform incorrect	Check the horizontal waveform generator circuit (Q51–Q55, U51 and L52–L53) on the deflection board (A3).
Picture fuzzy	Picture out of focus on image tube target	Check the setting of the FOCUS (R62) control on the front panel of the CCU. Check focus ring setting on the lens. Check lens adapter ring position. Check focus regulator circuit (U51) on the video preamplifier board (A4).
Picture tilted	Incorrect orientation of deflection and focus coil subassembly	Reposition coil assembly.

2. Interconnect the Camera with the CCU and a tv monitor known to be in good adjustment.
3. On the CCU front panel, set the POWER switch to ON.
4. On the CCU front panel, rotate the FOCUS adjustment fully ccw.
5. Set the voltmeter for measuring 1060 and 700 V dc in succeeding steps of this procedure. Connect the common lead to the test point labled GND (figure 5-1).
6. On the Camera deflection board (A3), connect the voltmeter probe to TP20 (1060 V dc).
7. On the Camera deflection board (A3), adjust the H V Set (high voltage set) potentiometer (R28) to obtain 1060±5 V dc on the voltmeter.
8. Move the voltmeter probe from TP20 to TP21 (700 V dc).
9. Adjust the G3 Set (grid 3 set) potentiometer (R22) to obtain 700±5 V dc on the voltmeter.
10. Move the voltmeter probe from TP21 to TP20.
11. On the CCU front panel, vary the FOCUS adjustment through its full range and verify a minimum range on the voltmeter from 900 to 1060 V dc.
12. Remove the voltmeter probe from TP20 and the common lead from the ground.
13. Set the voltmeter to measure about 6.3 V dc.
14. Connect the voltmeter common lead (floating) to TP82 and the probe lead to TP81.
15. Adjust the Fil Adj (filament adjust) potentiometer (R82) to obtain 6.3 V dc on the meter.

Table 5-3. Internal Adjustments

LOCATION	NAME	FUNCTION
Lens well at front of Camera	Lens adapter ring	Adjusts the distance between image tube target and imaging lens to establish overall optical focus
Behind front end plate of Camera	Deflection coil assembly	Can be rotated to adjust orientation of scanning pattern on image tube target
Video preamplifier board (A4)	Frequency trim control (C9)	Flattens frequency response from start of bandwidth to about 7 MHz
	Frequency trim control (C11)	Flattens frequency response from about 8 to 20 MHz
	Frequency trim control (C10)	Flattens frequency response from about 20 to 30 MHz
	Bandwidth adjust (C33)	Reduces the bandwidth and/or spurious oscillations in the output stage
Deflection board (A3)	Horizontal linearity (L52)	Adjusts linearity of horizontal scan
	High voltage set (R28)	Adjusts the dc potential on grid 4 of the image tube
	Grid 3 set (R22)	Adjusts the dc potential on grid 3 of the image tube
	Skew adjust (R76)	Adjusts to make vertical lines perpendicular to horizontal lines

16. Disconnect the voltmeter leads.
17. On the CCU front panel, set the POWER switch to OFF.
18. Replace the Camera cover.
19. Put the Camera back into operation. It will be necessary to adjust the focus at the Camera (section 3-1) and the CCU (table 3-1), for the scene to be televised.

5.4.2 Lens Adapter Ring and Focus Adjustments

The instructions for mechanical focus adjustments are divided into two parts: section 5.4.2.1 when using a CTJ-2 Cohu test jig and collimator and section 5.4.2.2 for use when the test jig is not available.

Electrical focusing adjustments are established by a potentiometer at the CCU. These adjustments appear in table 3-1.

5.4.2.1 Test Jig With Collimator Focusing – To adjust mechanical focus when using a Cohu test jig, with collimator, proceed as follows:

1. On the CCU front panel, set the POWER switch to OFF.

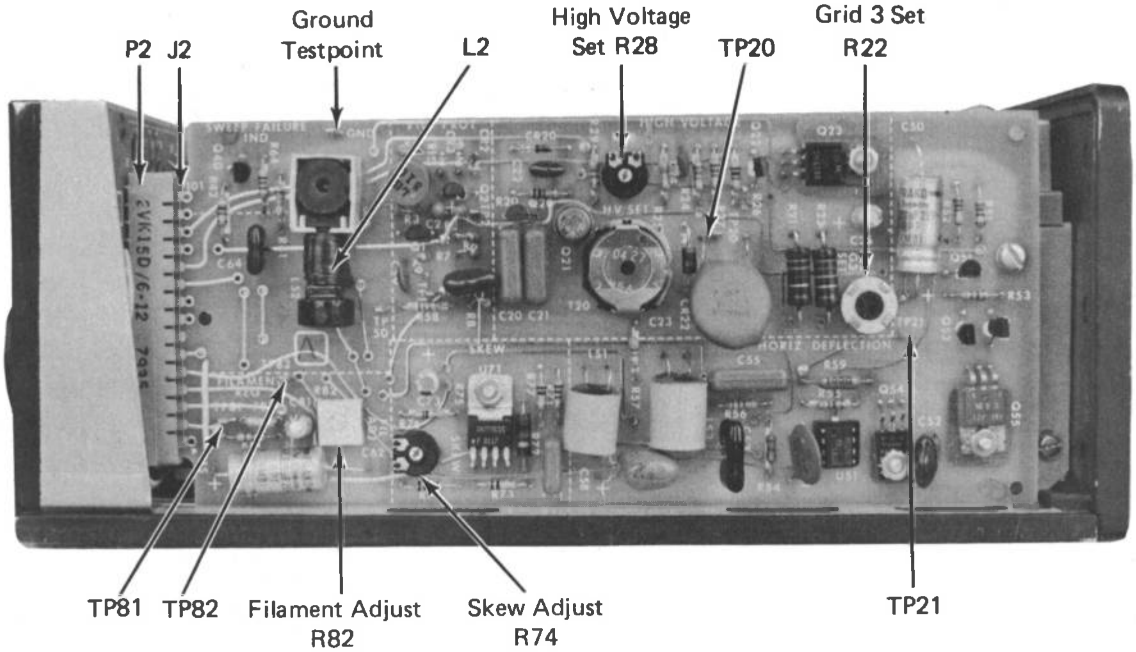


Figure 5-1. Camera Deflection Board (A3) Adjustments

2. On the CCU front panel, set the TARGET AUTO/MAN switch to AUTO.
3. Place the Camera in a CTJ-2 test jig facing the resolution chart.
4. Position the collimator so that it is as close to the test pattern as the calibrated standoffs will allow.
5. Set the lens focus ring to line up the infinity mark with the focus point.
6. Set the iris fully open.
7. Establish subdued room lighting.

NOTE

Do not turn on the lamp that back illuminates the pattern on the test jig.

8. On the CCU front panel, set the POWER switch to ON.
9. Loosen, with a 5/64 in. hex wrench, the setscrew that holds the lens adapter ring from turning (figure 5-2).
10. Slowly turn the lens-adapter ring and lens clockwise or counterclockwise in the Camera lens well until sharp focus is attained, as observed on the system tv monitor.
11. Tighten the setscrew to prevent the lens adapter from turning in the lens well.
12. Remove the Camera from the test jig.
13. Select a lens aperture appropriate for the illumination on the scene to be televised. Indoor scenes with average illumination usually will require settings from f/1.9 to f/3.5 while outdoor scenes in daylight typically require settings from f/5.6 to f/22.

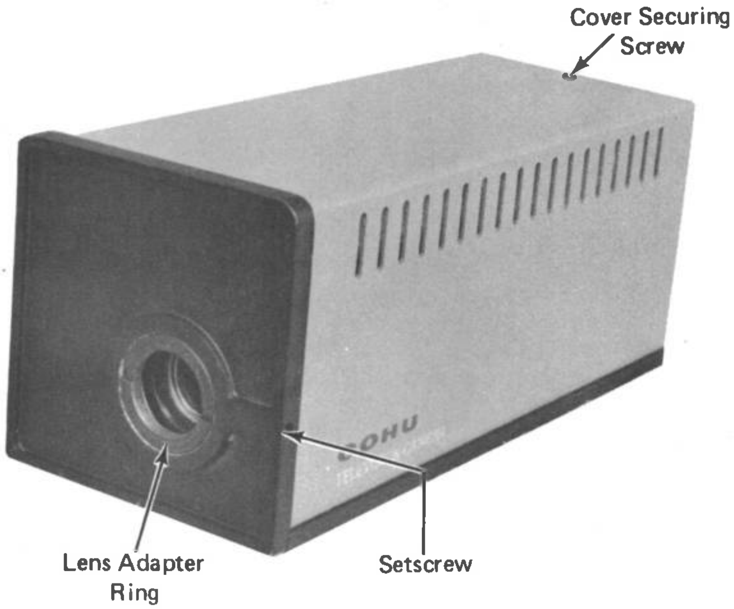


Figure 5-2. Lens Adapter Ring and Locking Setscrew

14. Follow the steps outlined in section 3.1 for lens focus ring adjustment. For extreme lighting conditions establish manual control of the Camera and follow the steps outlined in table 3-1.

5.4.2.2 **Focusing Without Test Jig and Collimator** – To adjust mechanical focus when a test jig and collimator are not available, proceed as follows:

1. Establish subdued room lighting.
2. Set the lens iris to its maximum opening.
3. Set the lens focus ring to the distance mark just before the infinity mark.
4. Point the Camera at a test pattern or a piece of printed matter taped to a wall or other plane surface parallel to the face of the Camera.
5. Position the Camera so that the distance from center of the lens to the scene corresponds to the focus distance setting of the lens.
6. Loosen, with a 5/64 in. hex wrench, the setscrew that holds the lens adapter ring from turning, (figure 5-2).
7. Slowly turn the lens-adapter ring and lens clockwise or counterclockwise in the Camera well until sharp focus is attained, as observed on the system tv monitor.
8. Tighten the setscrew to prevent the lens adapter from turning in the lens well.
9. Follow the procedure in section 3.1 for lens focus ring adjustment. For extreme lighting conditions, establish manual control of the Camera and follow the steps outlined in table 3-1.

5.4.3 Video Bandwidth and Gain Adjustment

To adjust the video bandwidth and gain of the Camera proceed as follow:

1. On the CCU front panel, set the POWER switch to OFF.
2. Remove the cover from the Camera as described in section 5.5.1.
3. Remove the Camera lens.
4. Install the vidicon simulator (VS-2) into the lens well. Ensure that the high-impedance output of the simulator is in good contact with the target ring on the end of the image tube.
5. Set up the test equipment as shown in figure 5-3.
6. Apply signal from the 50 or 75 ohm output of a sweep frequency generator to the low-impedance input of the simulator.
7. On the CCU front panel, set the POWER switch to ON.
8. Set the generator to sweep from about 100 kHz to about 50 MHz, set sweep rate at about 50 or 60 Hz, and set the sweep signal amplitude at 100 mV p-p (20 dB below 1 volt).
9. Place an oscilloscope probe on TP31 of the video preamplifier board to observe the video output signal.
10. Verify that sync is present in the video signal at TP31.

NOTE

The Camera video preamplifier may be swept without regard to the CCU video path. They are both flat and independent of each other. Sweep should be flat ±0.1 dB/MHz out to 32 MHz.

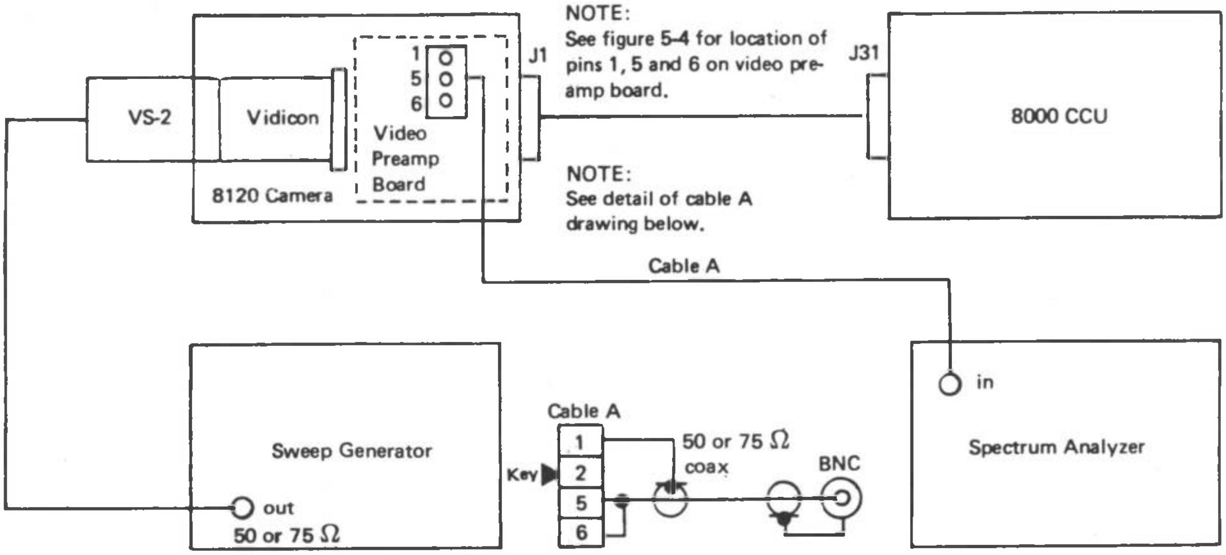


Figure 5-3. Test Setup, Gain and Bandwidth Adjustments

11. Adjust C9 for a flat response from the start of the bandwidth out to 7 MHz. (Figure 5-4 shows adjustment locations on the video preamplifier board.)

12. Adjust C11 to flatten the response from 8 to 20 MHz.

13. Adjust C10 to flatten the response from 20 to 30 MHz.

14. Adjust C33 to reduce the bandwidth and/or possible spurious oscillations in the output stage. It should reduce the gain out beyond 30 MHz but must not degrade the 0 to 32 MHz response.

15. Readjust C10, if necessary, to restore the frequency response.

16. On the CCU front panel, set the POWER switch to OFF.

17. Remove the test equipment. Replace the Camera cover.

18. Put the Camera back into operation.

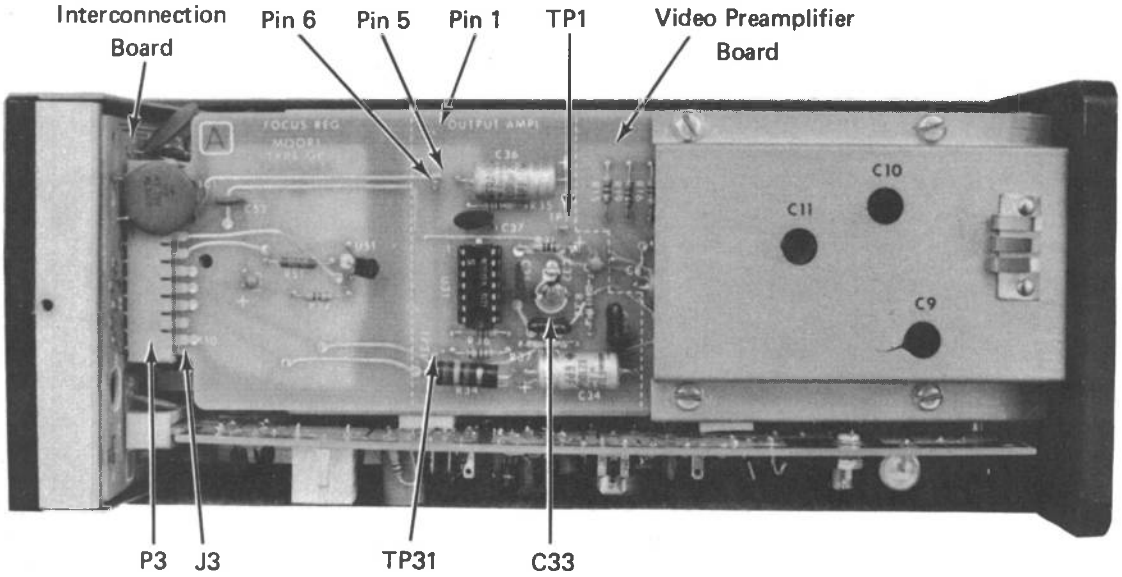


Figure 5-4. Video Preamplifier Board (A4) Adjustments

5.4.4 Scan Linearity Adjustment

Most of the adjustments for linearizing scan are shown in figure 5-5, the left side view of the Camera. Other related adjustments appear in figure 5-1 (Camera deflection board) and in figure 3-1 (CCU front panel). To perform these adjustments, proceed as follows:

1. On the CCU front panel, set the POWER switch to OFF.

2. Remove the cover from the Camera, as described in section 5.5.1.

3. Insert a dot-bar generator in the video line between the video output terminal of the CCU and the video input of the tv monitor.

4. Place the Camera in a test jig facing a back-illuminated linearity chart. If a test jig is not available

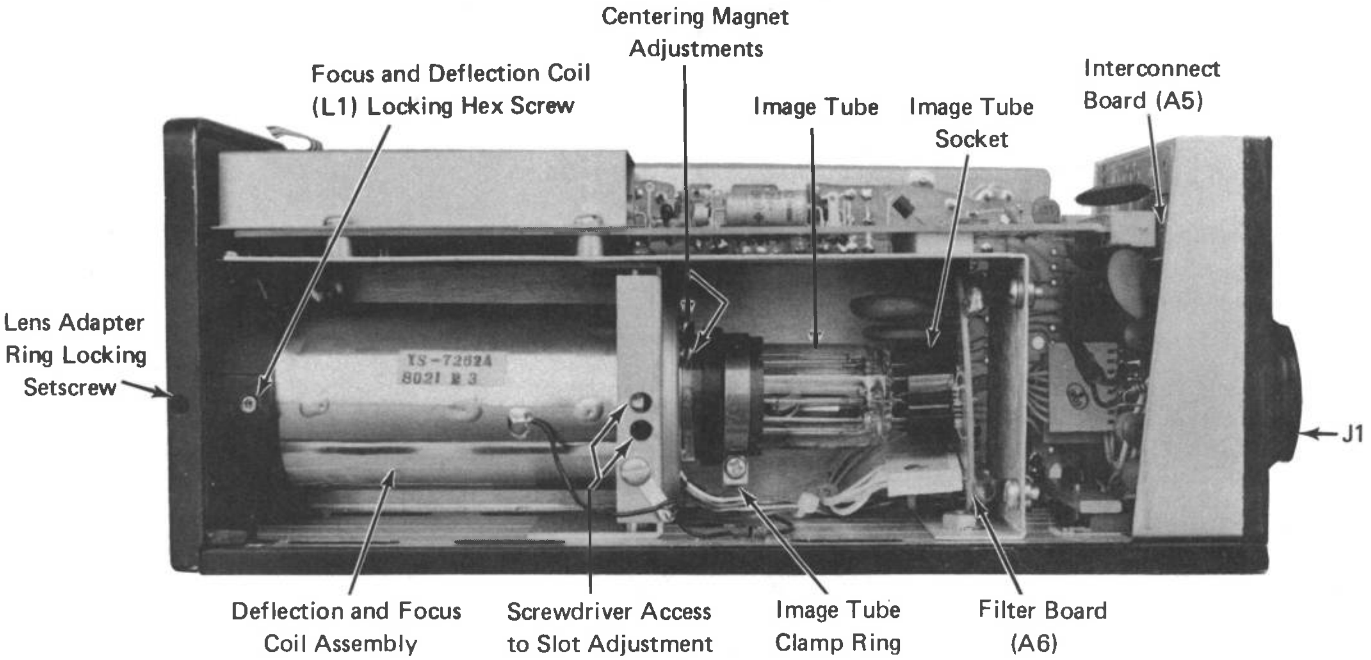

Centering Magnet Adjustments
Focus and Deflection Coil (L1) Locking Hex Screw
Image Tube
Image Tube Socket
Interconnect Board (A5)
Lens Adapter Ring Locking Setscrew
J1
Deflection and Focus Coil Assembly
Screwdriver Access to Slot Adjustment
Image Tube Clamp Ring
Filter Board (A6)

Figure 5-5. Camera Left Side Maintenance Features

tape the linearity chart from the back of this manual to a wall or other plane surface parallel to the face of the Camera.

5. Position the Camera so the optical axis of the lens is perpendicular to and centered on the chart.

6. On the CCU front panel, set the POWER switch to ON.

7. Adjust the distance from the Camera to the test pattern so that the arrows on the edges of the pattern just meet the blanking edges.

8. If necessary adjust VERT CENT, VERT SIZE, HORIZ CENT, and HORIZ SIZE potentiometers, located on the CCU front panel, for proper aspect ratio. (Refer to section 12.5.6).

9. Turn on the dot-bar generator. The crosshatch pattern from the dot-bar generator should be superimposed on the linearity chart so that the intersection of vertical and horizontal lines fall within the circles.

WARNING

Shock potential as high as 1100 volts is present at the base of the image tube.

10. If the linearity chart image on the monitor raster is tilted with respect to the crosshatch pattern, loosen the 5/64 in. hex screw (figure 5-5) that tightens the clamp around the focus-and-deflection coil assembly (L1).

11. Rotate the deflection coil by inserting a flat-blade screwdriver into the upper or lower slot provided (figure 5-5) and gently pivot up or down as required, while observing the results on a tv monitor, until the picture is properly oriented.

12. Retighten the deflection coil locking hex screw.

13. Adjust the alignment magnets (figure 5-5) for best corner resolution.
14. Adjust the horizontal-linearity control (L52) and the Skew control (R76) to make the crosshatching fall within corresponding circles.
15. Readjust the VERT SIZE and HORIZ SIZE potentiometers, located on the front panel of the CCU, to keep the monitor raster filled out with the test pattern.

NOTE

Geometric distortion will be within ±1% if the crosshatch can be made to fall within the center of their corresponding circles. If any crosshatch touches the annulus of its circle, the geometric distortion will be within ±2%. Geometric distortion will be greater than 2% if any crosshatch is outside its circle.

16. On the CCU front panel, set the POWER switch to OFF.
17. Remove the test equipment.
18. Replace the Camera cover.
19. Put the Camera back into operation and focus on the scene to be televised, as required.

5.5 SUBASSEMBLY REMOVAL, REPAIR AND REPLACEMENT

The active components in the Camera, for the most part, are installed on three printed circuit boards labeled video preamplifier, deflection, and filter. Each of these printed circuit boards is secured to the Camera chassis with one or more screws, the removal of which makes it possible to reposition the board so repair or replacement of components can be done without completely removing the board from the chassis. Special care must be taken, however, to avoid damaging wires to other points in the Camera. These particular wires must be unsoldered or disconnected if the board is to be removed completely from the Camera.

5.5.1 Camera Cover Removal

To make test points, internal adjustments and components inside the Camera accessible for servicing:

1. On the CCU front panel, set the POWER switch to OFF.
2. Remove the screw located in the top center of the back edge of the Camera cover using a 1/16 in. hex wrench.
3. Pull the cover slightly toward the rear of the chassis and lift off.

WARNING

Up to 1100 volts dc is exposed when the Camera is operated with its cover removed.

5.5.2 Image Tube Replacement

The usual indications of a defective vidicon are: burned out filaments, permanent raster burns, and low cathode emission as evidenced by reduced Camera sensitivity and poor shading and/or loss of detail contrast in picture. Use the following procedure to replace an image tube:

1. On the CCU front panel, set the POWER switch to OFF.
2. Disconnect the Camera-to-CCU cable and place the Camera on a work bench.
3. Remove the cover from the Camera (section 5.5.1).
4. Loosen the lens adapter ring setscrew and unscrew the lens and lens adapter ring as a unit.
5. Loosen the screw on the image tube clamp ring.
6. Unplug the tube socket from the base while slowly and carefully pushing the image tube toward the front of the deflection yoke assembly.
7. Slide the image tube completely out the deflection yoke through the lens opening at the front of the Camera.
8. Rotate the new tube so the short index pin on its base is at 3:00 o'clock, as viewed from the front of the Camera, and insert it in the deflection yoke assembly.
9. Tighten the screw on the image tube clamp ring at the rear of the deflection yoke assembly and then plug the tube socket firmly into the base of the image tube.
10. Clean the faceplate on the image tube and exposed faces of the imaging lens (section 5.2.2).
11. Replace the lens adapter ring and temporarily tighten the setscrew.
12. Reinstall the lens finger tight.
13. Replace the Camera cover.
14. Connect the Camera to the CCU.
15. On the CCU front panel, set the POWER switch to ON.
16. Perform the focusing adjustments in section 5.4.2 and the scan linearity adjustments in section 5.4.4 to return the Camera to normal operation.

5.5.3 Video Preamplifier Board Removal

To remove the video preamplifier board from the Camera chassis proceed as follows:

1. On the CCU front panel, set the POWER switch to OFF.
2. Remove the Camera cover as described in section 5.5.1.
3. Remove the four screws securing the shield and video preamplifier board to the Camera chassis, using a No. 2 flat-blade screwdriver.
4. Unsolder the target wire (TGT 1), located on the rear edge of the video preamplifier board.

5. Carefully pull the video preamplifier board out of the interconnect board socket.
6. Reassembly is done in reverse order.

5.5.4 Deflection Board Removal

To remove the deflection board from the Camera chassis proceed as follows:

1. On the CCU front panel, set the POWER switch to OFF.
2. Remove the Camera cover as described in section 5.5.1.
3. Remove the screw securing the deflection board to the chassis, using a No. 2 flat-blade screwdriver.
4. Slide the board straight back out of the interconnect board socket.
5. Reassembly is done in the reverse order.

5.5.5 Interconnect Board Removal

If it is necessary to remove the interconnect board from the Camera chassis proceed as follows:

1. On the CCU front panel set the POWER switch to OFF.
2. Disconnect the Camera-to-CCU cable and place the Camera on a work bench.
3. Remove the Camera cover as described in section 5.5.1.
4. Remove the video preamplifier board as described in section 5.5.3 (it is not necessary to unsolder the target wire).
5. Remove the transistor clamp, located on the Camera base, using a No. 2 flat-blade screwdriver.
6. Remove the screw securing the interconnect board mounting bracket to the Camera base, using a No. 2 flat-blade screwdriver.
7. Remove the four screws securing the Camera rear panel to the Camera base, using a No. 2 flat-blade screwdriver.
8. Slide the Camera rear panel away from the deflection board and lift off the Camera base.
9. Remove the four screws, located on the Camera rear panel that secure the multipin connector (J1) to the Camera rear panel, using a No. 2 cross-blade screwdriver.
10. Separate the interconnect board from the Camera rear panel.
11. Reassembly is done in reverse order.

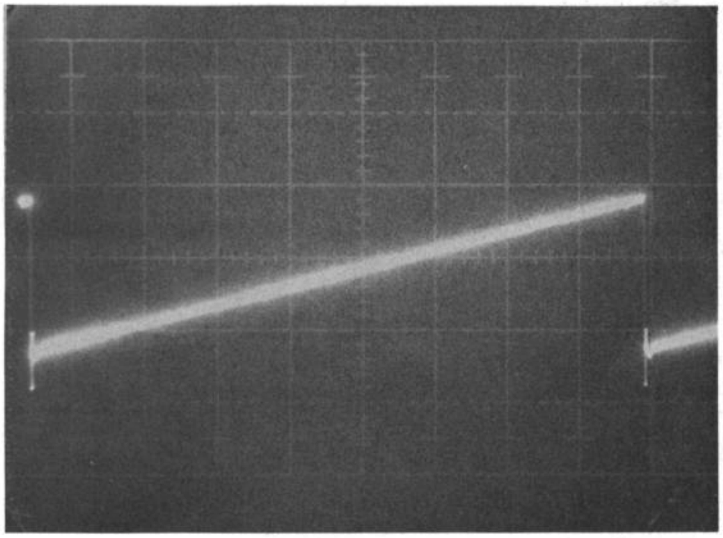
5.5.6 Filter Board Removal

To remove the filter board from the Camera chassis proceed as follows:

1. On the CCU front panel set the POWER switch to OFF.
2. Remove the Camera cover as described in section 5.5.1.
3. Unplug the tube socket from the base of the image tube.
4. Remove the two screws securing the ground straps on the filter board to the Camera chassis, using a No. 2 flat-blade screwdriver.
5. Unplug connector P41 and remove the filter board from the Camera chassis.
6. Reassembly is done in reverse order.

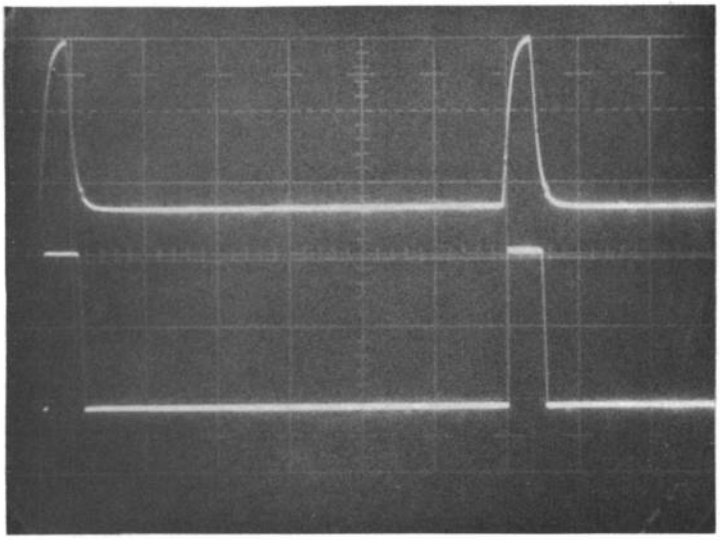
5.6 WAVEFORMS

Figures 5-6 and 5-7 illustrate typical waveforms for circuits contained within the Camera. These waveforms were taken at test points throughout the circuits with the Camera monitoring a resolution test pattern. The waveforms present for some circuits may vary with different control settings, so an interpretation of circuit action is important when using these waveforms for maintenance.



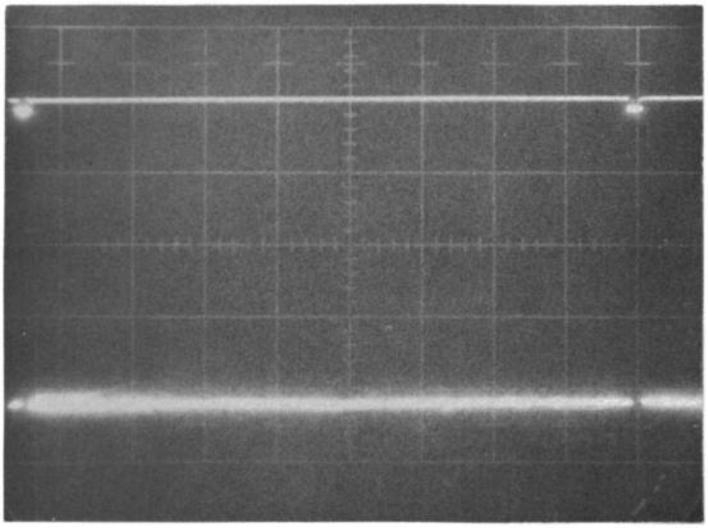
TP1
5 V/cm 2 ms/cm

Figure 5-6. Waveforms, Deflection Board (A3), Sheet 1 of 4

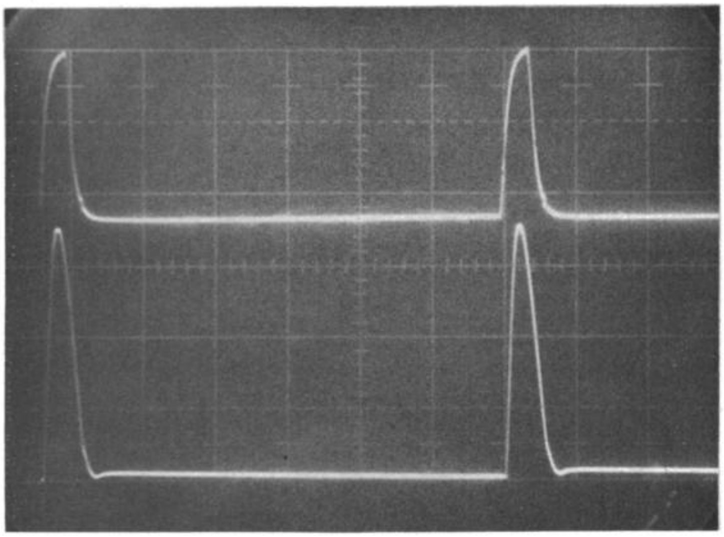


P2-112
2 V/cm 10 µs/cm

TP2
10 V/cm 10 µs/cm



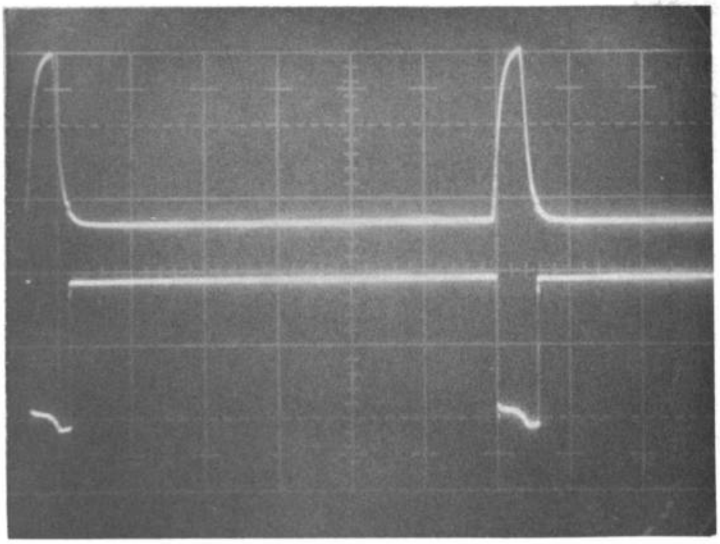
TP2
5 V/cm 2 ms/cm



P2-112
2 V/cm 10 µs/cm

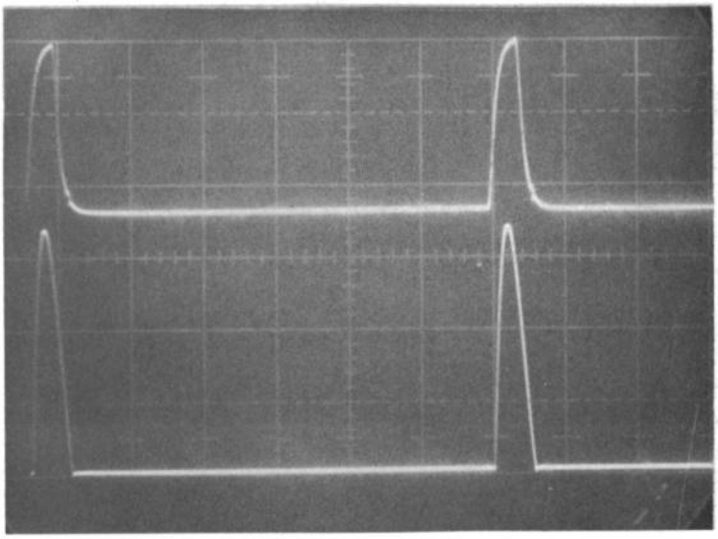
TP50
20 V/cm 10 µs/cm

Figure 5-6. Waveforms, Deflection Board (A3), Sheet 2 of 4



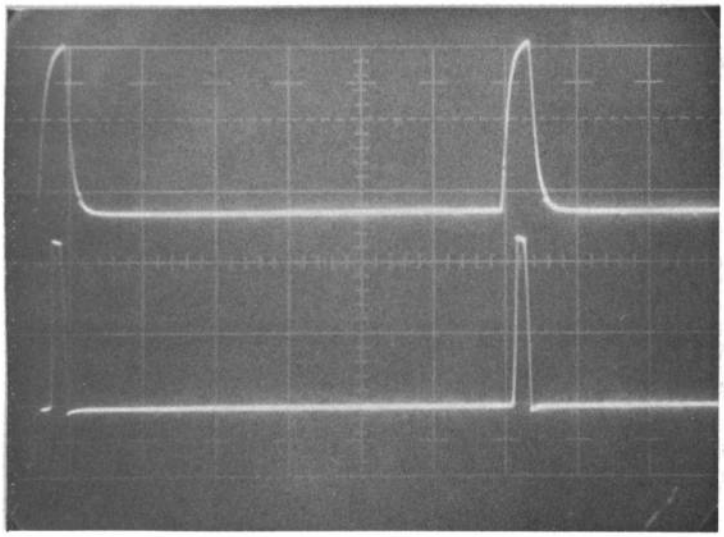
P2-112
2 V/cm 10 μs/cm

Q52-E
5 V/cm 10 μs/cm



P2-112
2 V/cm 10 μs/cm

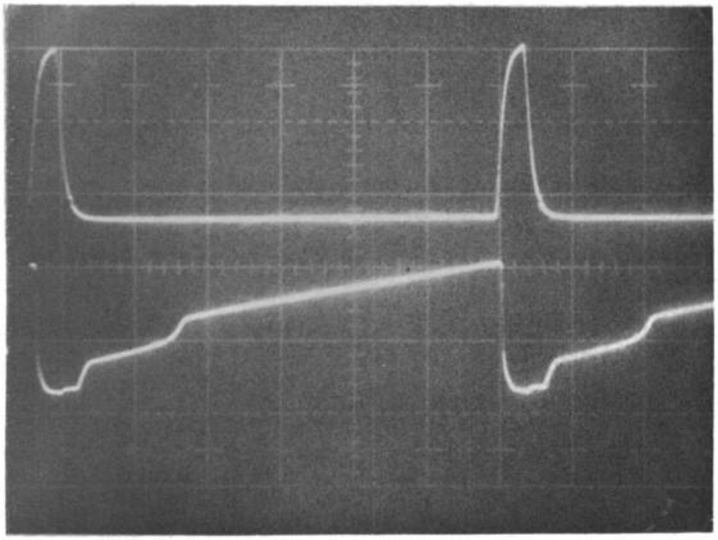
Q55-D
50 V/cm 10 μs/cm



P2-112
2 V/cm 10 μs/cm

Q21-C
100 V/cm 10 μs/cm

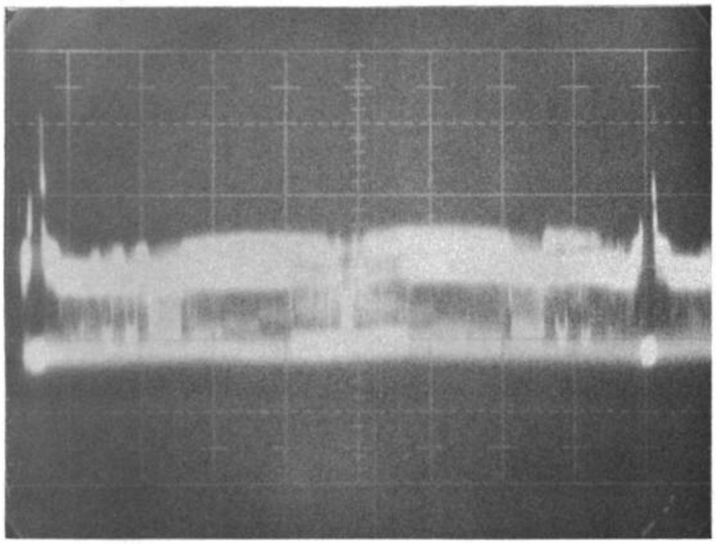
Figure 5-6. Waveforms, Deflection Board (A3), Sheet 3 of 4



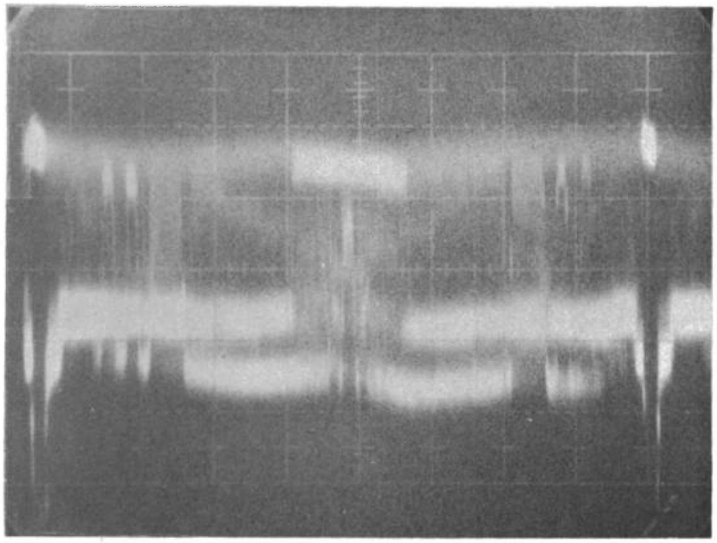
P2-112
2 V/cm 10 μs/cm

Q20-C
2 V/cm 10 μs/cm

Figure 5-6. Waveforms, Deflection Board (A3), Sheet 4 of 4



TP1
0.1 V/cm 2ms/cm



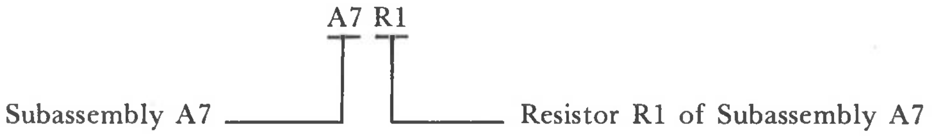
TP31
0.1 V/cm 2 ms/cm

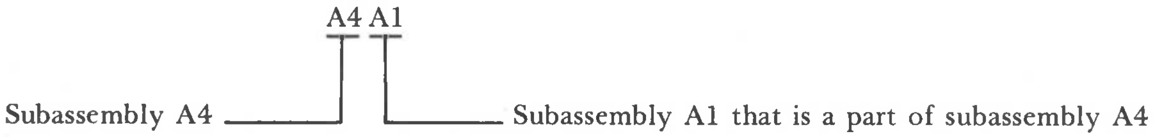
Figure 5-7. Waveforms, Video Preamplifier Board (A4)

PART ONE – CAMERA

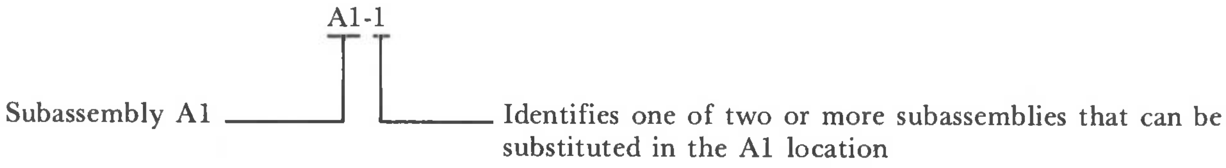
SECTION VI
PARTS LISTS

This section contains parts listings for the unit described in the manual. The first parts list identifies items related to the main chassis. Subsequent parts lists are for the subassemblies contained therein. They appear in reference-designation order. This system of identification places assemblies and components in order by alphabetical and numerical designations. For example:





If more than one type of assembly can be installed in a position, numbers are added to the end of their reference designations to distinguish them. For example:


A1-1
Subassembly A1
Identifies one of two or more subassemblies that can be substituted in the A1 location

Unused reference designations are not listed; thus, notations such as Not Used do not appear in a parts list sequence where reference designations are skipped.

Included in the lists are electrical components–resistors, transistors, ICs, and the like–together with closely associated parts such as connectors, IC sockets, and fuses. Mechanical parts subjected to wear, damage, or loss in normal use appear in the lists, too.

Illustrations are placed with the parts lists as an aid in identifying component locations and other features.

All parts are identified by name and description together with a Cohu part number. Transistors, diodes, ICs, and similar parts may also be identified by the name and part number of a particular manufacturer. Equivalent parts from other manufacturers may be substituted; however, if the designation "only" appears together with the manufacturer and part-number reference, no substitution should be made. Only the exact part from that manufacturer is acceptable. In all cases, though, the Cohu part number can be used to order the part from either the factory or an authorized representative.

Table 6.1 Model 8120 Camera Parts List

REF DES	DESCRIPTION	COHU PART NUMBER
	8460001-001 ISSUE 2	
A3	Deflection Board	8460031-001
A4	Preamplifier Board	8460041-001
A5	Interconnection Board	8460051-001
A6	Filter Board	8560025-001
L1	Coil, Focus Deflection	681034-001
L2	Inductor, Ferrite Bead	4910020-001
L3	Same as L2	
P4	Connector, 3 Contact	1310300-003
P6	Connector, 2 Contact	1310300-002
P7	Same as P6	
P11	Connector, 8 Contact	1310300-008
P41	Same as P11	
	Key	1310300-151

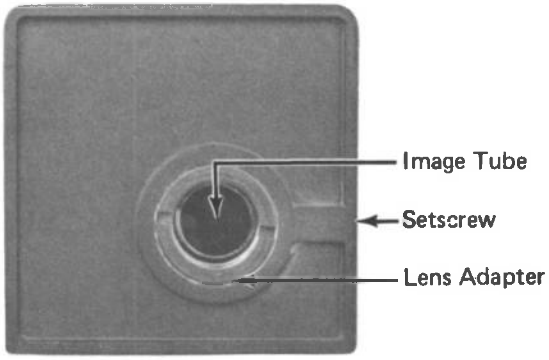


Figure 6-1. Model 8120 Camera, Front View, Location of Components

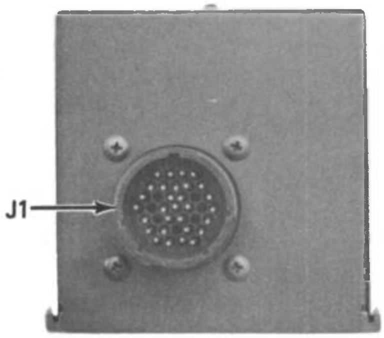


Figure 6-2. Model 8120 Camera, Rear View, Location of Components

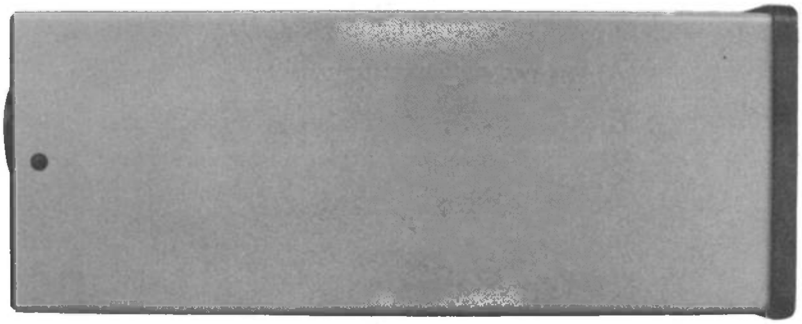


Figure 6-3. Model 8120 Camera, Top View, Location of Components

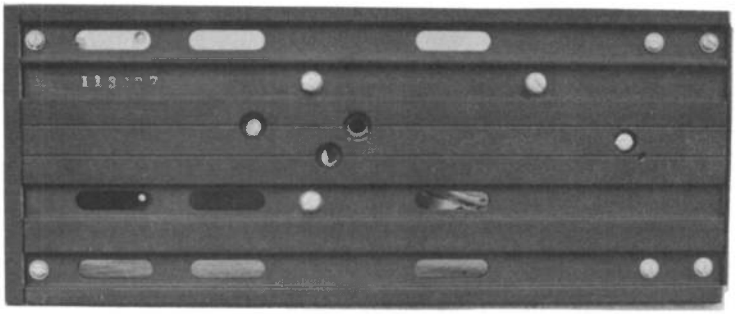


Figure 6-4. Model 8120 Camera, Bottom View, Location of Components

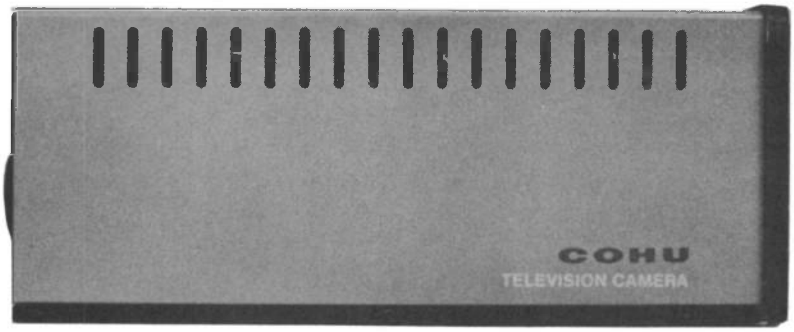


Figure 6-5. Model 8120 Camera, Right View, Location of Components

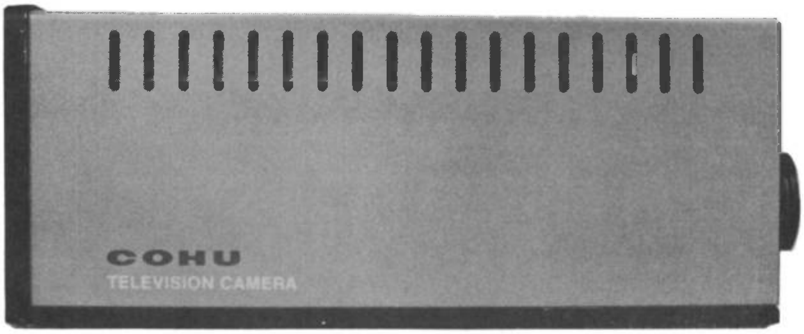


Figure 6-6. Model 8120 Camera, Left View, Location of Components

Table 6-2. Type 8460031-001 Deflection Board (A3) Parts List

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 2	
C2	Capacitor, Tantalum, 1 µF, ±20%, 25 V	0510155-004
C3	Capacitor, Film, 0.1 µF, ±10%, 100 V	0610157-104
C20	Capacitor, Film, 0.47 µF, ±20%, 100 V	0610136-474
C21	Same as C20	
C22	Capacitor, Film, 0.047 µF, ±10%, 100 V	0610157-473
C23	Capacitor, Ceramic Disk, 0.02 µF, ±20%, 1.4 kV	0410013-001
C24	Capacitor, Ceramic Disk, 0.01 µF, ±35%, 50 V	0410009-103
C25	Capacitor, Electrolytic, 22 µF, –20 +75%, 25 V	0510166-226
C50	Capacitor, Electrolytic, 220 µF, –10 +20%, 25 V	0510160-018
C51	Capacitor, Ceramic Disk, 0.1 µF, –20 +80%, 10 V	0410036-002
C52	Same as C3	
C53	Capacitor, Silver Mica, 1500 pF, ±5%, 500 V	1010007-152
C55	Same as C20	
C58	Capacitor, Tantalum, 100 µF, ±20%, 20 V	0510155-003
C59	Capacitor, Ceramic Disk, 150 pF, ±20%, 1 kV	0401025
C62	Same as C50	
C64	Capacitor, Silver Mica, 680 pF, ±5%, 500 V	1010006-681
C71	Capacitor, Film, 0.22 µF, ±20%, 100 V	0610136-224
C73	Capacitor, Electrolytic, 4.7 µF, –20 +75%, 50 V	0510166-475
C81	Same as C25	
CR1	Diode, Switch, 1N4148	3510043-029
CR2	Same as CR1	
CR3	Same as CR1	
CR20	Same as CR1	
CR21	Diode, 1N4005	3510018-018
CR22	Diode, MA-30 (High Voltage Devices)	3510076-004
F81	Fuse, Pigtail, 0.5 A, 125 V	1710056-104
L1	Inductor, 10 mH, ±5%, 50 mA	2310085-310
L51	Inductor, 47 mH, ±5%, 80 mA	2310086-347
L52	Coil, Horizontal Linearity	2310088-001
L53	Inductor, 10 mH, ±5%, 100 mA	2310086-310
Q1	Transistor, 2N3905	7210072-001
Q2	Same as Q1	
Q20	Transistor, Darlington Amplifier, MPS-A14 (Motorola)	7210095-001
Q21	Transistor, 2N3439	7210035-057
Q22	Transistor, Field Effect, 2N5462	721084-003
Q23	Transistor, Darlington Power, 2N6386	7210113-001
Q40	Transistor, PN3567-5 (Motorola)	7210072-018
Q51	Transistor, 2N4124	7210072-002
Q52	Same as Q51	
Q53	Transistor, 2N4126	7210072-003
Q54	Transistor, 2N4918	7210085-002

Table 6-2. Type 8460031-001 Deflection Board (A3) Parts List (Cont'd)

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 2	
Q55	Transistor, MOSFET, IRF 721 (International Rectifier)	7210119-001
R3	Resistor, Carbon Film, 10 Kilohm, ±5%, ¼ W	4010025-103
R4	Same as R3	
R5	Resistor, Carbon Film, 100 Kilohm, ±5%, ¼ W	4010025-104
R6	Same as R3	
R7	Resistor, Carbon Film, 22 Kilohm, ±5%, ¼ W	4010025-223
R8	Resistor, Carbon Film, 15 Kilohm, ±5%, ¼ W	4010025-153
R9	Resistor, Carbon Film, 1000 Ohm	4010025-102
R20	Same as R9	
R21	Resistor, Carbon Film, 4.7 Megohm, ±5%, 1 W	4010021-475
R22	Resistor, Variable, 5 Megohm, ±20%, ¼ W	5010115-505
R23	Resistor, Carbon Film, 12 Megohm, ±5%, 1 W	4010021-126
R24	Same as R7	
R25	Resistor, Carbon Film, 470 Kilohm, ±5%, ¼ W	4010025-474
R26	Same as R9	
R27	Resistor, Carbon Film, 1.5 Megohm, ±5%, ¼ W	4010025-155
R28	Resistor, Variable, 10 Kilohm, ±20%, 1/5 W	5010147-103
R29	Resistor, Carbon Film, 4700 Ohm, ±5%, ¼ W	4010025-472
R41	Resistor, Carbon Film, 13 Kilohm, ±5%, ¼ W	4010025-133
R42	Resistor, Carbon Film, 9100 Ohm, ±5%, ¼ W	4010025-912
R51	Resistor, Carbon Film, 75 Ohm, ±5%, ¼ W	4010025-750
R52	Resistor, Carbon Film, 1500 Ohm, ±5%, ¼ W	4010025-152
R53	Same as R29	
R54	Resistor, Carbon Film, 3600 Ohm, ±5%, ¼ W	4010025-362
R55	Same as R29	
R56	Resistor, Carbon Film, 2200 Ohm, ±5%, ¼ W	4010025-222
R57	Resistor, Carbon Film, 47 Kilohm, ±5%, ¼ W	4010025-473
R58	Resistor, Carbon Film, 1800 Ohm, ±5%, ¼ W	4010025-182
R59	Resistor, Carbon Film, 100 Ohm, ±5%, ¼ W	5110032-101
R64	Same as R58	
R71	Resistor, Carbon Film, 1 Megohm, ±5%,	4010025-105
R72	Resistor, Composition, 100 Ohm, ±5%, ½ W	0310030-101
R73	Same as R5	
R74	Same as R5	
R75	Resistor, Carbon Film, 200 Kilohm, ±5%, ¼ W	4010025-204
R76	Resistor, Variable, 100 Kilohm, ±20%, 1/5 W	5010147-104
R77	Same as R5	
R81	Resistor, Carbon Film, 180 Ohm, ±5%, ¼ W	4010025-181
R82	Resistor, Variable, 20 Ohm, ±20%, ½ W	5010135-200
T20	Transformer	8458236-001
TP1	Terminal, Single Pin Test Point	1710280-001
TP2	Same as TP1	

Table 6-2. Type 8460031-001 Deflection Board (A3), Parts List (Cont'd)

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 2	
TP20	Same as TP1	
TP21	Same as TP1	
TP50	Same as TP1	
TP81	Same as TP1	
TP82	Same as TP1	
U51	Operational Amplifier, 741	3610108-001
U71	Operational Amplifier, μA759	3610239-001
XU	Socket, Integrated Circuit, 8-pin	1710292-004

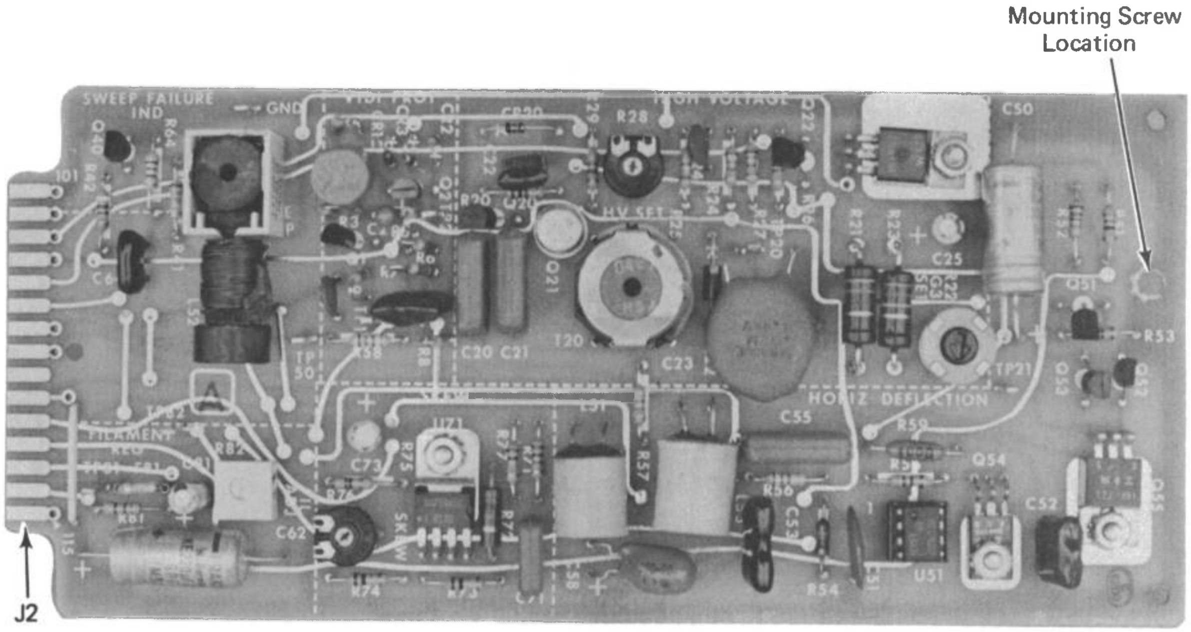


Figure 6-7. Type 8460031-001 Deflection Board (A3), Location of Components

Table 6-3. Type 8460041-001 Video Preamplifier Board (A4) Parts List

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 3	
C1	Capacitor, Polyester, 0.01 μF, ±10%, 80 V	0610128-103
C2	Capacitor, Film, 0.022 μF, ±20%, 100 V	0610136-223
C3	Capacitor, Film, 0.22 μF, ±20%, 100 V	0610136-224
C4	Same as C3	
C5	Capacitor, Ceramic Disk, 0.05 μF, -20 +80%, 20 V	0410036-003
C6	Capacitor, Electrolytic, 220 μF, -10 +100%, 16 V	0510160-009
C7	Same as C5	
C8	Same as C6	
C9	Capacitor, Variable, 4 – 40 pF	0910014-005
C10	Same as C9	
C11	Capacitor, Variable, 2 – 8 pF, -50 +70%	0910013-002
C13	Capacitor, Tantalum, 22 μF, ±20%, 15 V	0510155-005
C31	Same as C13	
C32	Capacitor, Silver Mica, 5±0.5 pF, 500 V	1010006-050
C33	Capacitor, Variable, 1.7 – 6 pF	0910014-002
C34	Capacitor, Electrolytic, 100 μF, -10 +100%, 25 V	0510160-017
C35	Same as C5	
C36	Same as C34	
C37	Same as C5	
C38	Capacitor, Silver Mica, 2±0.5 pF, 500 V	1010006-020
C51	Capacitor, Tantalum, 1 μF, ±20%, 35 V	0510155-004
C52	Capacitor, Ceramic Disk, 0.01 μF, ±35%, 50 V	0410009-103
Q1	Transistor, Field Effect, E211 (Siliconix)	7210112-002
Q2	Same as Q1	
Q3	Transistor, PN3563 (National)	7210072-017
Q4	Transistor, PN3640 (National)	7210072-016
Q5	Same as Q3	
Q6	Same as Q4	
Q7	Same as Q3	
R1	Resistor, Film, 1 Megohm, ±1%, ¼ W	4710044-015
R2	Resistor, Carbon Film, 100 Kilohm, ±5%, ¼ W	4010025-104
R3	Resistor, Carbon Film, 680 Ohm, ±5%, ¼ W	4010025-681
R4	Same as R3	
R7	Resistor, Carbon Film, 1600 Ohm, ±5%, ¼ W	4010025-162
R8	Resistor, Carbon Film, 1200 Ohm, ±5%, ¼ W	4010025-122
R9	Resistor, Carbon Film, 470 Ohm, ±5%, ¼ W	4010025-471
R10	Resistor, Carbon Film, 360 Ohm, ±5%, ¼ W	4010025-361
R11	Resistor, Carbon Film, 47 Ohm, ±5%, ¼ W	4010025-047
R12	Same as R8	
R13	Resistor, Carbon Film, 360 Kilohm, ±5%, ¼ W	4010025-364
R14	Resistor, Carbon Film, 2700 Ohm, ±5%, ¼ W	4010025-272
R15	Resistor, Carbon Film, 47 Ohm, ±5%, ¼ W	4010025-470

Table 6-3. Type 8460041-001 Video Preamplifier Board (A4) Parts List (Cont'd)

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 3	
R16	Same as R9	
R17	Same as R8	
R18	Resistor, Carbon Film, 27 Ohm, ±5%, ¼ W	4010025-270
R19	Resistor, Carbon Film, 2000 Ohm, ±5%, ¼ W	4010025-202
R31	Resistor, Carbon Film, 1000 Ohm, ±5%, ¼ W	4010025-102
R32	Resistor, Carbon Film, 330 Ohm, ± 5%, ¼ W	4010025-331
R33	Resistor, Carbon Film, 4300 Ohm, ±5%, ¼ W	4010025-432
R34	Resistor, Composition, 270 Ohm, ±5%, ¼ W	0310031-271
R35	Resistor, Carbon Film, 56 Ohm, ±5%, ¼ W	4010025-560
R36	Same as R9	
R37	Resistor, Carbon Film, 75 Ohm, ±5%, ¼ W	4010025-750
R51	Resistor, Precision, Wirewound, 24 Ohm, 1%, ½ W	5110043-001
R52	Resistor, Carbon Film, 4700 Ohm, ±5%, ¼ W	4010025-472
TP1	Terminal, Single Pin Test Point	1710280-001
TP31	Same as TP1	
U31	Operational Amplifier NE5539N (Signetic)	3610273-001
U51	Regulator, Adjustable Shunt TL431CLP (TI)	3610274-001
XU1	Socket, Integrated Circuit, 14-Pin	1710292-007

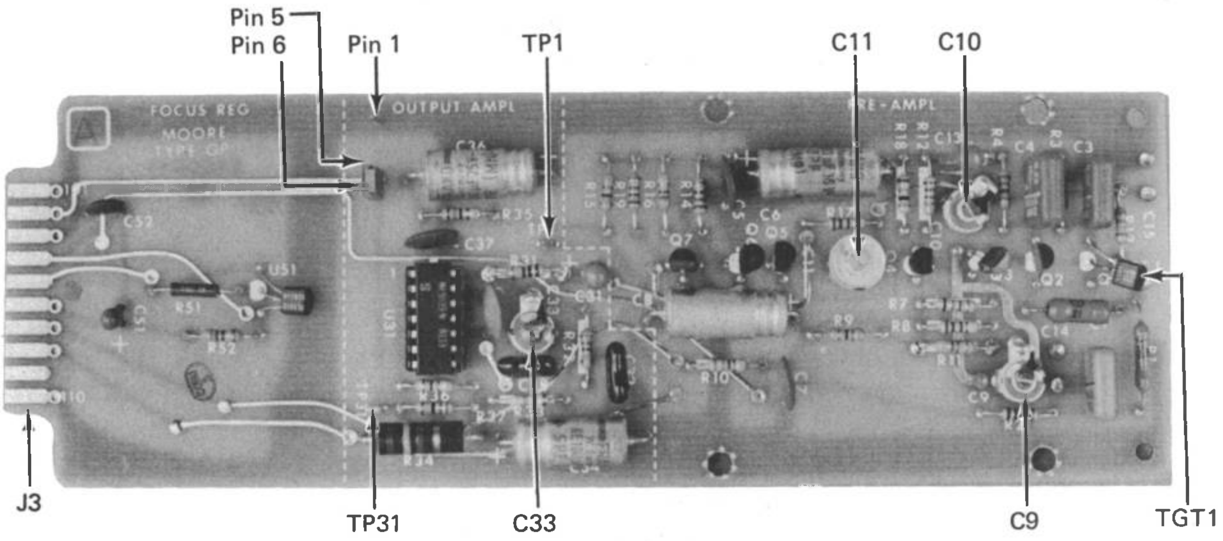


Figure 6-8. Type 8460041-001 Video Preamplifier Board (A4), Location of Components

Table 6-4. Type 8460051-001 Interconnection Board (A5) Parts List

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 3	
C1	Capacitor, Ceramic Disk, 0.01 μF, ±35%, 50 V	0410009-103
C2	Same as C1	
C3	Same as C1	
C4	Same as C1	
C7	Capacitor, Ceramic Disk, 0.01 μF, -0%, 1000 V	0410013-004
C8	Same as C1	
C12	Capacitor, Ceramic Disk, 0.01 μF, -20 +80%, 200 V	0407316-007
C13	Same as C7	
C14	Same as C1	
C17	Same as C1	
C19	Same as C1	
C20	Same as C1	
C21	Same as C1	
C22	Same as C1	
C23	Same as C1	
C24	Same as C1	
C27	Capacitor, Electrolytic, 22 μF, -10 +50%, 16 V	0510156-926
C28	Capacitor, Ceramic Disk, 0.022 μF, -20 +80%, 20 V	0410036-003
J1	Receptacle, Square Flange, Standard	1310306-002
J2	Connector, Card Edge, 30 Terminal	1310277-030
J3	Connector, Card Edge, 20 Terminal	1310277-020
Q2	Transistor, 2N5296	7210099-002
R1	Resistor, Carbon Film, 1000 Ohm, ±5%, ¼ W	4010025-102
U1	Voltage Regulator, LM7906 (Motorola)	3610144-106

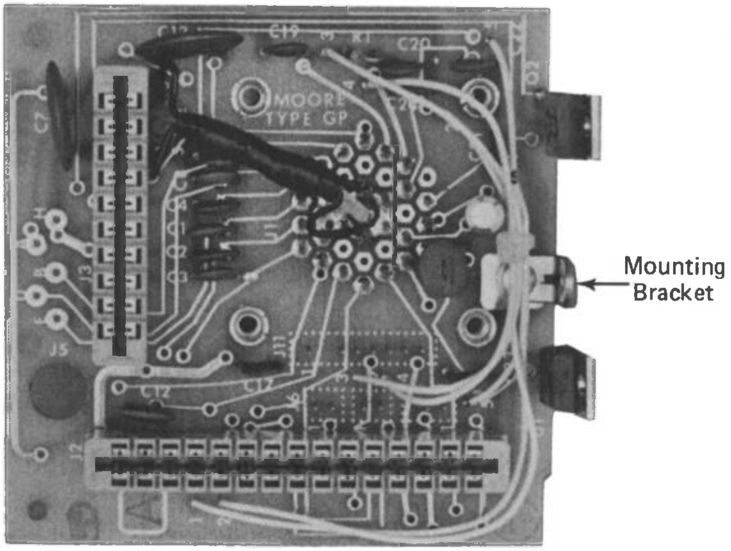


Figure 6-9. Type 8460051-001 Interconnect Board (A5), Location of Components

Table 6-5. Type 8460025-001 Filter Board (A6) Parts List

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 1	
C1	Capacitor, Ceramic, 0.02 μF, ±20%, 1.4 kV	0410013-001
C2	Capacitor, Ceramic Disk, 0.05 pF, ±20%, 600 V	0401059
C3	Capacitor, Ceramic, 0.01 μF, -0%, 1 kV	0410013-004
C4	Same as C2	
CR1	Diode, Zener, 6.8 V, 1N5235C	3510036-067
L1	Inductor, Ferrite Bead,	4910020-001
L2	Same as L1	
R1	Resistor, Carbon Film, 22 Kilohm, ±5%, ¼ W	4010025-223
R2	Resistor, Carbon Film, 1 Megohm, ±5%, ¼ W	4010025-105
R3	Same as R2	
R4	Same as R2	
XV1	Socket, Vidicon	1710295-001

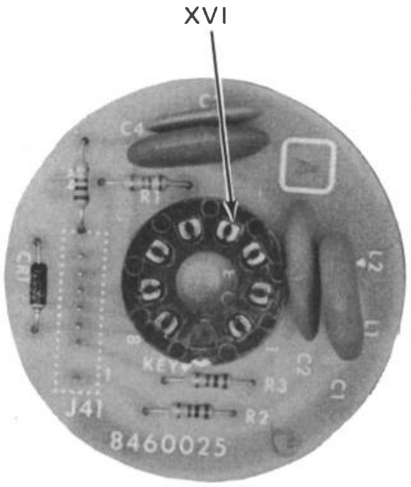
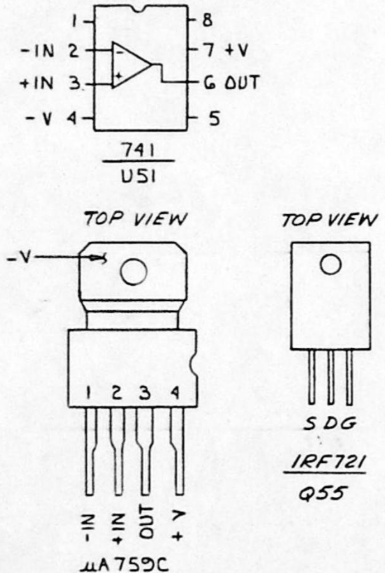
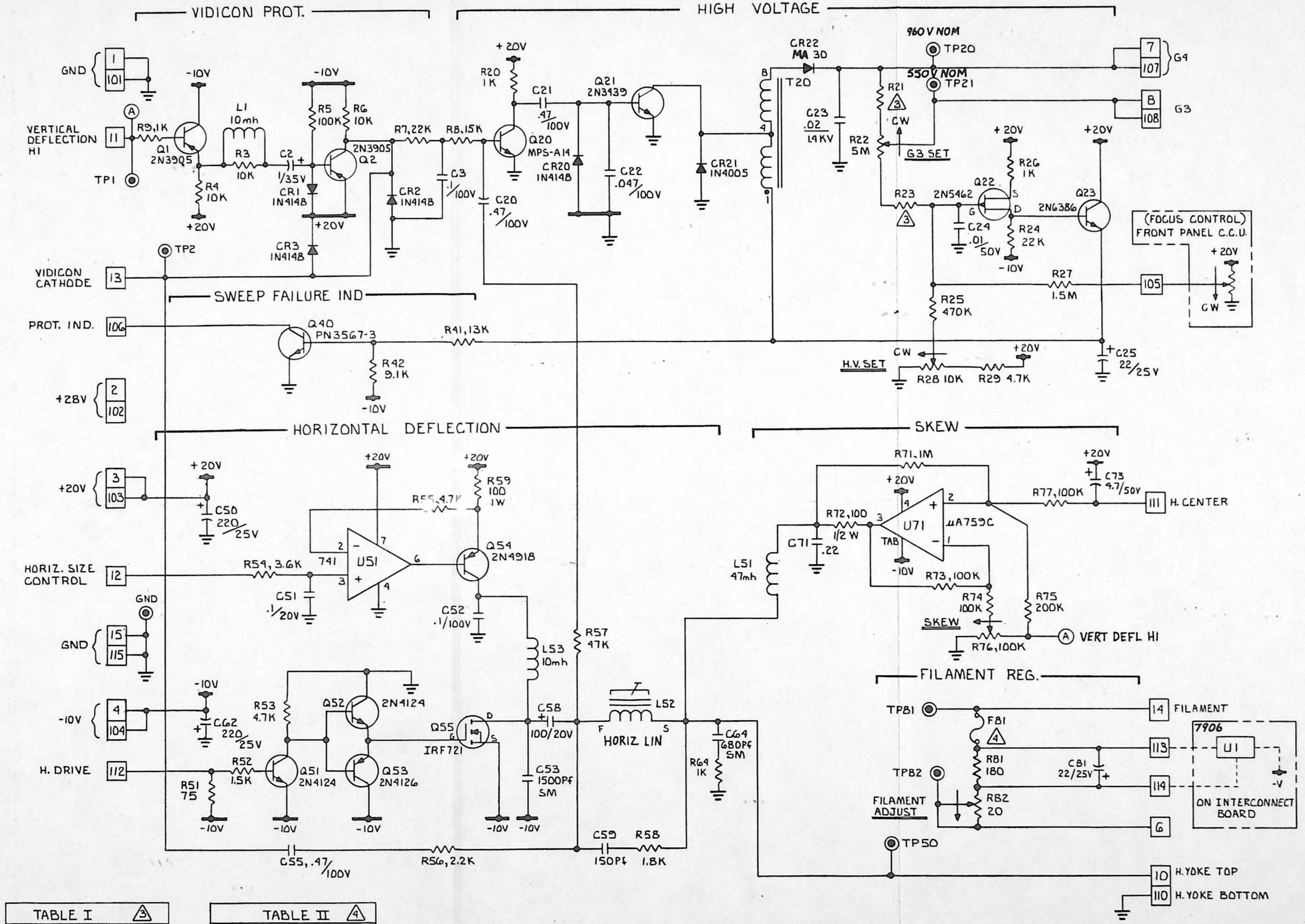


Figure 6-10. Type 8460025-001 Filter Board (A6), Location of Components

PART ONE – CAMERA

SECTION VII
SCHEMATIC DIAGRAMS





NOTES:
UNLESS OTHERWISE SPECIFIED:

1. All resistor values are in ohms, ¼ W, ±5%.
2. All capacitor values are in microfarads.
3.

△3. See Table I for values.

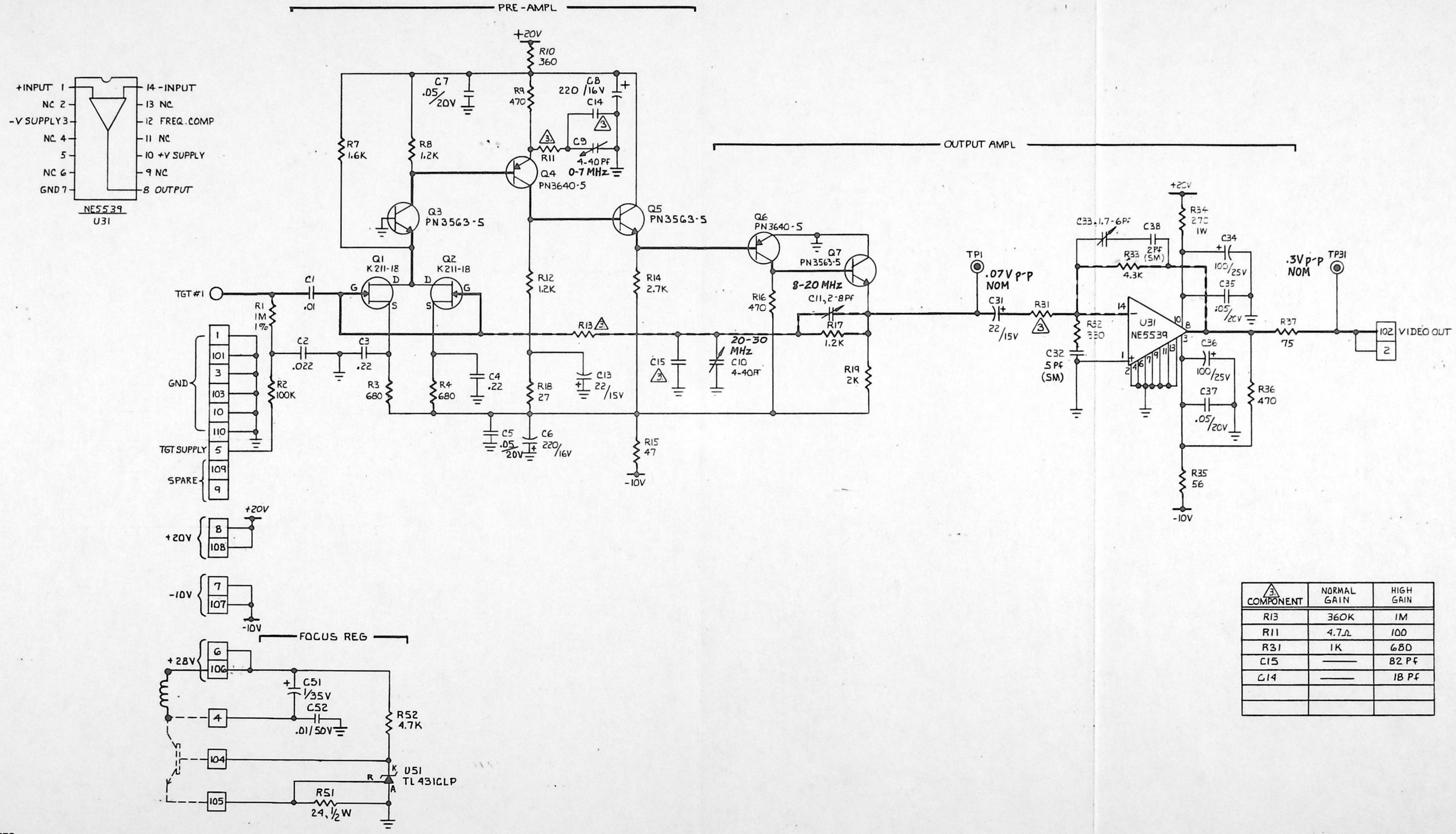
△4. See Table II for values.

TABLE I △3		
COMP	VIDICON	SILICON
R21	4.7M, 1W	JUMPER
R23	12M, 1W	3.9M, 1/2W

TABLE II △4		
	VIDICON FILAMENT	
COMP	100 MA	600 MA
F81	1/2 A	1.5A

(from dwg D8460030B)

Figure 7-1. Type 8460031-001 Deflection Board (A3), Schematic Diagram

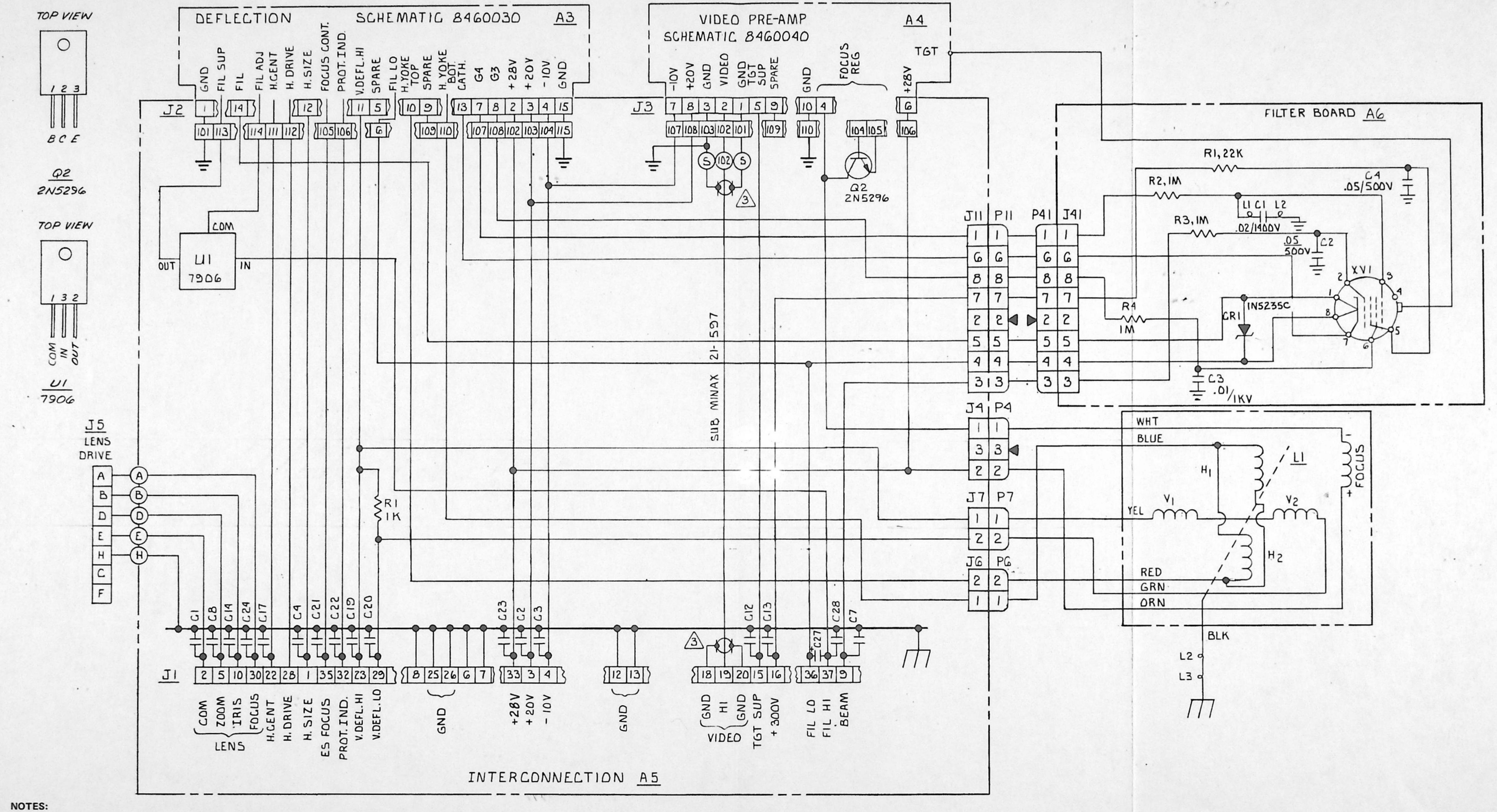


3 COMPONENT	NORMAL GAIN	HIGH GAIN
R13	360K	1M
R11	4.7Ω	100
R31	1K	680
C15	———	82 PF
C14	———	18 PF

NOTES:
UNLESS OTHERWISE SPECIFIED:
1. All resistor values are in ohms, ¼ W, ±5%.
2. All capacitor values are in microfarads.
3. See table for values.

(from dwg D8460040C)

Figure 7-2. Type 8460041-001 Video Preamplifier Board (A4), Schematic Diagram


TOP VIEW
1 2 3
B C E
Q2
2N5296
TOP VIEW
1 3 2
COM IN OUT
U1
7906
J5
LENS DRIVE
A B D E H C F
DEFLECTION SCHEMATIC 8460030 A3
GND FIL SUP FIL FIL ADJ H.CENT H. DRIVE H. SIZE FOCUS CONT. PROT. IND. V.DEFL.HI SPARE FIL LO H.YOKE TOP SPARE H.YOKE BOT CATH. G4 G3 +28V +20V -10V GND
J2
VIDEO PRE-AMP SCHEMATIC 8460040 A4
-10V +20V GND VIDEO GND TGT SUP SPARE GND FOCUS REG +28V TGT
J3
Q2 2N5296
COM
OUT U1 7906 IN
SUB MINAX 21-597
R1 1K
FILTER BOARD A6
R1, 22K
R2, 1M
R3, 1M
C4 .05/500V
L1 C1 L2
.02/1400V
.05 500V C2
XV1
R4 1M
CR1
1N5235C
C3 .01/1KV
J11 P11 P41 J41
J4 P4
J7 P7
J6 P6
WHT BLUE YEL RED GRN ORN BLK
H1 H2 V1 V2 L1 FOCUS
L2 L3
C1 C8 C14 C24 C17 C4 C21 C22 C19 C20 C23 C2 C3 C12 C13 C27 C28 C7
J1
COM ZOOM IRIS FOCUS LENS H.CENT H. DRIVE H. SIZE ES FOCUS PROT. IND. V.DEFL.HI V.DEFL.LO GND +28V +20V -10V GND GND HI GND VIDEO TGT SUP +300V FIL LO FIL HI BEAM
INTERCONNECTION A5

NOTES:
UNLESS OTHERWISE SPECIFIED:
1. All resistor values are in ohms, ¼ W, ±5%.
2. All capacitor values are in microfarads.
3. Dual forward shield at J1 per mm-1.
4. All capacitors on A5 are .01 microfarads, C7 & C13 are 1kV, C12 is 200 V, C27 22/16 V, C28 .05/20 V. All others are 50 V.
5. Focus coil resistance: 127Ω±5%
Vert Defl coil resistance, series connected (grn-yel) 61.2Ω±7% at 20° C
Horiz Defl coil resistance, parallel connected (red-blu) 6.1Ω±7% at 20° C

(from dwg D8460000B)

Figure 7-3. Model 8120 Camera, Schematic Diagram

PART TWO
CCU

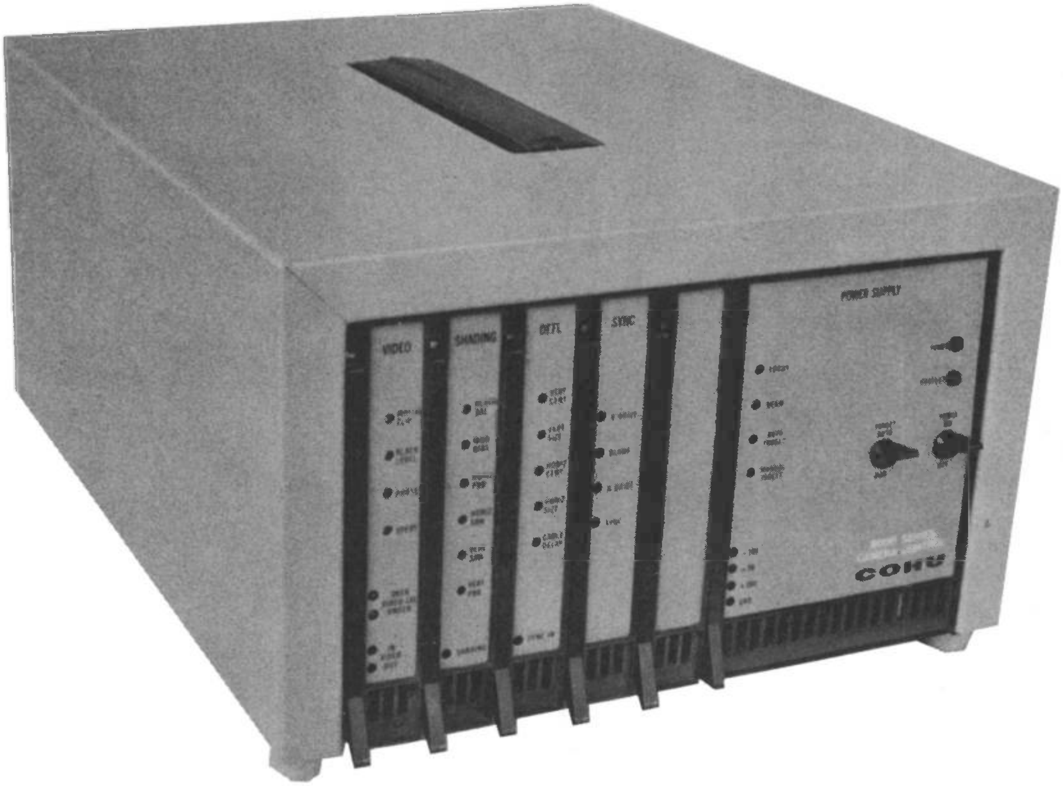


Figure 8-1. Model 8000 Camera Control Unit

PART TWO – CCU

SECTION VIII
GENERAL DESCRIPTION

The Cohu 8000 Series Camera Control Unit (CCU) shown in figure 8-1, houses controls for operating the 8120 television Camera described in part I of this manual. Together they are able to function in broadcast, educational, and other television applications. The CCU produces most of the dc supply voltage and deflection waveforms required for operation by the Camera. It also amplifies and shapes the video signal generated in the Camera.

The CCU is a solid-state electronic package available in either rack-mount or desk-top enclosures. A basic version consists of three standard plug-in etched circuit boards (video board, deflection board, and an extender board), a power supply assembly, fifteen front-panel adjustments and switches, eight rear-panel cable connectors, an internal interface board for the plug-ins, four indicator LEDs, and seven front panel test points. Two additional positions are provided in the chassis for either an optional sync or blanking generator and for an optional shading board.

In most applications the CCU will be located at some convenient point away from the Camera and connected to it with a single multiconductor cable. Without adversely affecting picture quality this cable length can be up to 2000 feet with an 8-MHz bandwidth resolution, up to 1000 feet with a 16-MHz bandwidth resolution, and up to 500 feet with a 32-MHz bandwidth resolution, when using a type CA-218 cable assembly. For distances of 25 feet or less, a type CA-219 superflex cable can be used.

8.1 ELECTRICAL CHARACTERISTICS

Most electronic circuits and operator controls necessary to operate the Camera are located remotely in the CCU. Access to the Camera should not be required for routine maintenance adjustment.

The power supply assembly furnishes most of the regulated as well as unregulated dc supply voltages needed by the Camera to operate. The CCU derives these operating voltages from either 115 or 230 volts ac, 50 or 60 Hz, with a maximum input power of 60 watts (table 1-1).

Wide range automatic circuits control target voltage, video gain, dark-current compensation, and high-frequency response. The TARGET AUTO/MAN switch selects automatic or manual sensitivity. Automatic sensitivity control maintains the video level constant within 6 dB for a change in vidicon faceplate illumination from 0.1 footcandle to 1000 footcandles. For scenes that have a high degree of specular lighting, an adjustable white-peak clipper control is provided to limit the video signal amplitude. Amplitude range of aperture correction is front panel adjustable from 0 to +10 dB with negligible phase distortion. Gamma correction is provided. This is jumper selectable for either 1 or 0.5 (white compression) to enhance details in the dark areas of the picture and either 1 or 1.3 (black compression) to enhance details in the white areas of the picture.

Video bandwidth is selectable (8 MHz, 16 MHz, or 32 MHz) through use of plug-in filters. The signal-to noise ratio for 32-MHz bandwidth resolution is 30 dB, for 16-MHz bandwidth resolution 38 dB, and for a 8-MHz bandwidth resolution 41 dB.

Video output signal is white positive, but a video polarity reversal option makes selection of positive or negative possible. Signal level is jumper selected to either 0.7 or 1.5 V p-p noncomposite, (1 or 2 V p-p composite). Video signal is applied to two BNC type 75-ohm, 5% source terminated, single ended outputs.

The Camera and CCU operate at any vertical-scan frequency between 50 and 60 Hz and horizontal-scan frequency between 15 and 37 kHz. Interlace of 4:3 is standard, but circuits can be adjusted to establish interlace of 2:1 or 1:1 if desired. Circuits in the CCU can be synced with an external 2-to-8 volt negative-going sync and blanking inputs. Two sets of BNC loop-through jacks are provided on the rear panel of the CCU for these signal inputs and outputs. Input impedance exceeds 1 kilohm during loop-through operation when the internal 75-ohm termination is removed.

Both horizontal- and vertical-deflection amplifiers are adjustable from a 10 percent underscan to a 10 percent overscan. Adjustments are provided for picture size and centering and for yoke vertical-to-horizontal angle error. Figure 8-2 shows a functional diagram of the CCU.

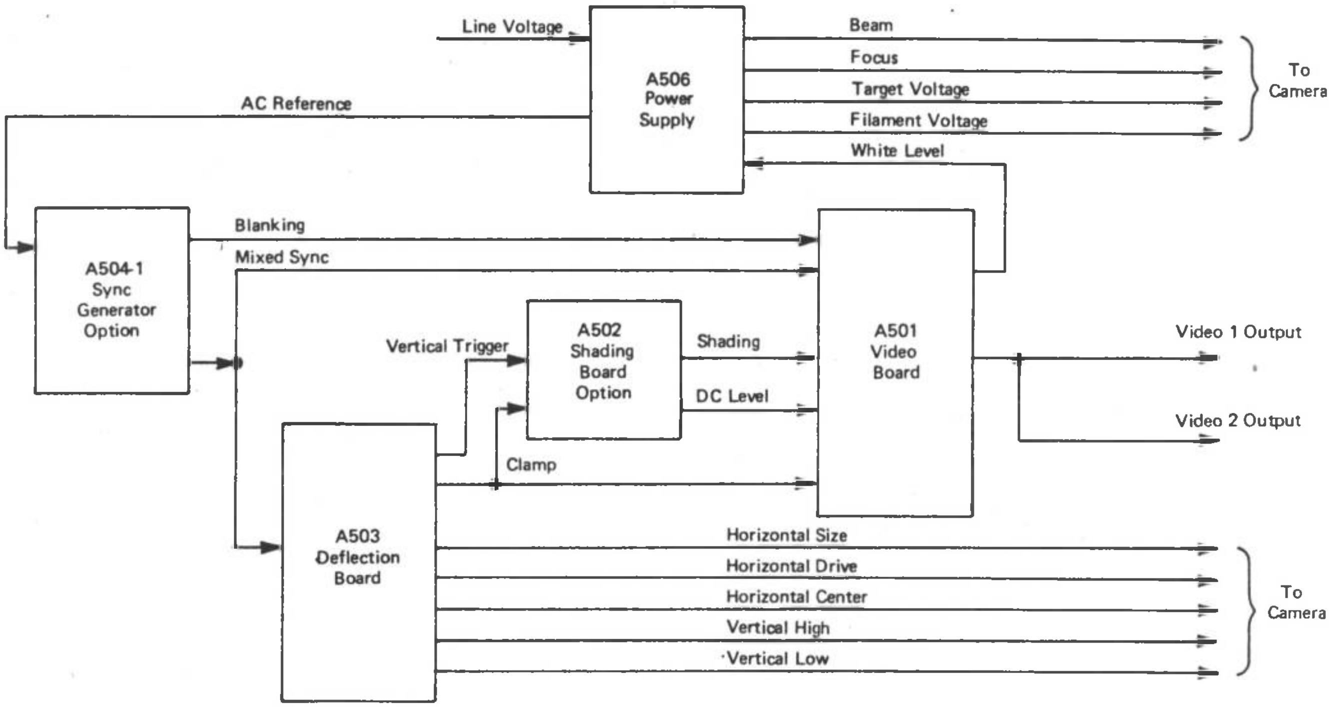


Figure 8-2. CCU Functional Diagram

8.1.1 Electrical Characteristics of Options

One position is provided in the CCU chassis for an optional sync generator (the sync generator contains circuits for blanking) or for a blanking generator (sync from an external source must be provided). A second position accepts a shading generator board.

8.1.1.1 Sync Generator Board – With the optional sync generator board installed, the CCU can generate odd-scan rates of 405 to 1225 lines per frame 50/60 Hz, 2:1 interlace, or by switch selection, scan rates of 1227 to 1749, 4:1 interlace. Vertical-sync interval contains equalizing pulses and vertical-sync pulses to EIA RS-170 or RS-343-A format or by jumper change to CCIR format.

The master oscillator can operate in either of two jumper-selectable modes, crystal controlled or locked to the ac power-line frequency.

8.1.1.2 Blanking Generator Board – With the optional blanking generator board installed the Camera operates from an external sync signal meeting EIA RS-170, RS-330, RS-343-A, or CCIR standards (figures 8-3, 8-4 and 8-5). The external signal must contain vertical-sync serrations. The blanking generator supplies the CCU and Camera with vertical- and horizontal-blanking pulses.

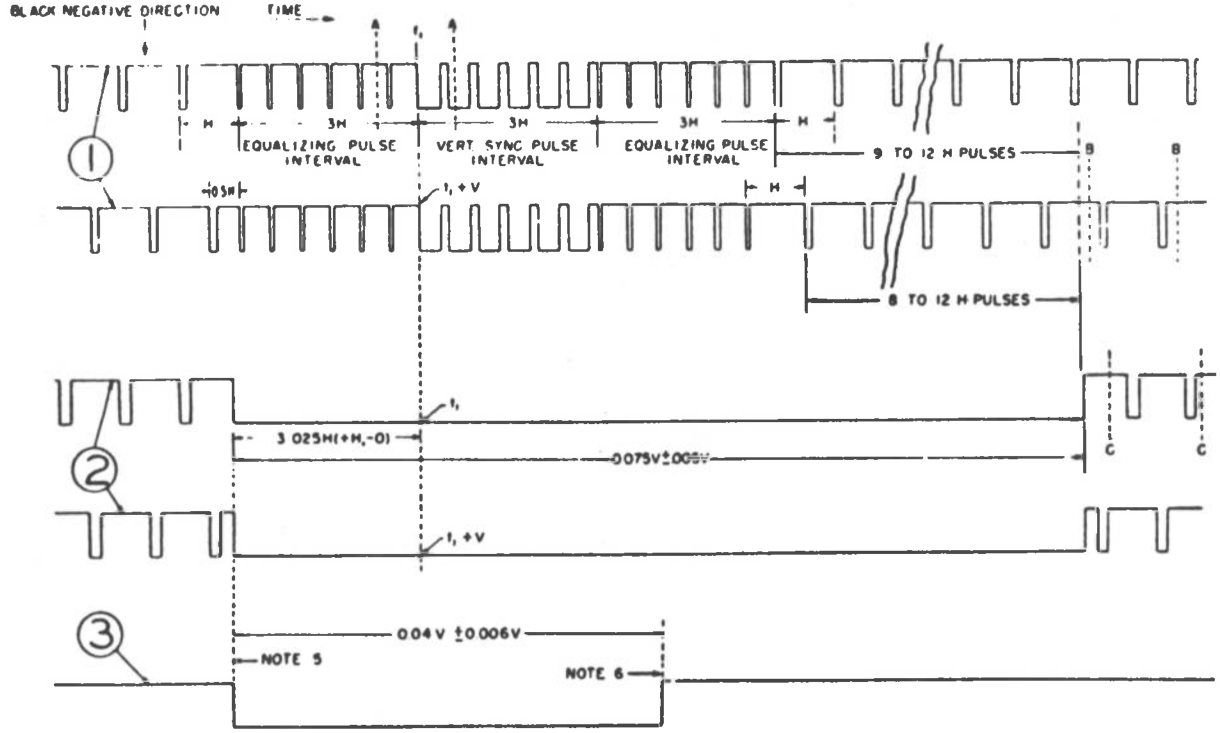
8.1.1.3 Shading Generator Board – With the optional shading generator board installed, shading correction consists of horizontal- and vertical-parabola and sawtooth waveforms. Shading correction is effective on both positive- and negative-polarity video. Shading is adjustable to less than 8 percent peak-to-peak of total video.

8.2 MECHANICAL CHARACTERISTICS

MONOCHROME TELEVISION
STANDARD SYNC
GENERATOR WAVEFORMS

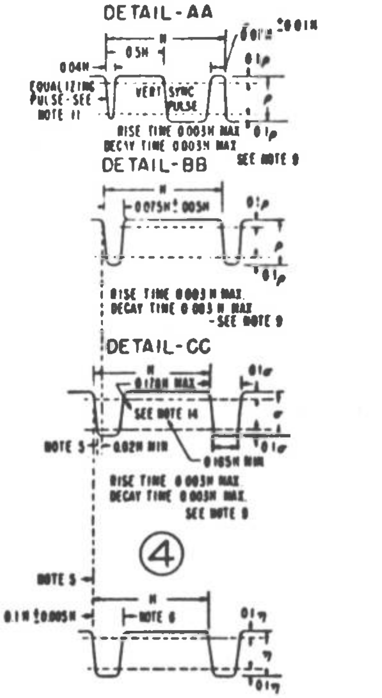
① SYNC SIGNAL
② BLANKING SIGNAL
③ VERTICAL DRIVING SIGNAL
④ HORIZONTAL DRIVING SIGNAL

All signal amplitudes shall be adjustable over the range from 3.5 to 4.5 volts across a load impedance of 75 ohms ±5%. Negative signal polarity shall be available for all pulses. Source impedance for all output circuits shall be 75 ohms ±10%.



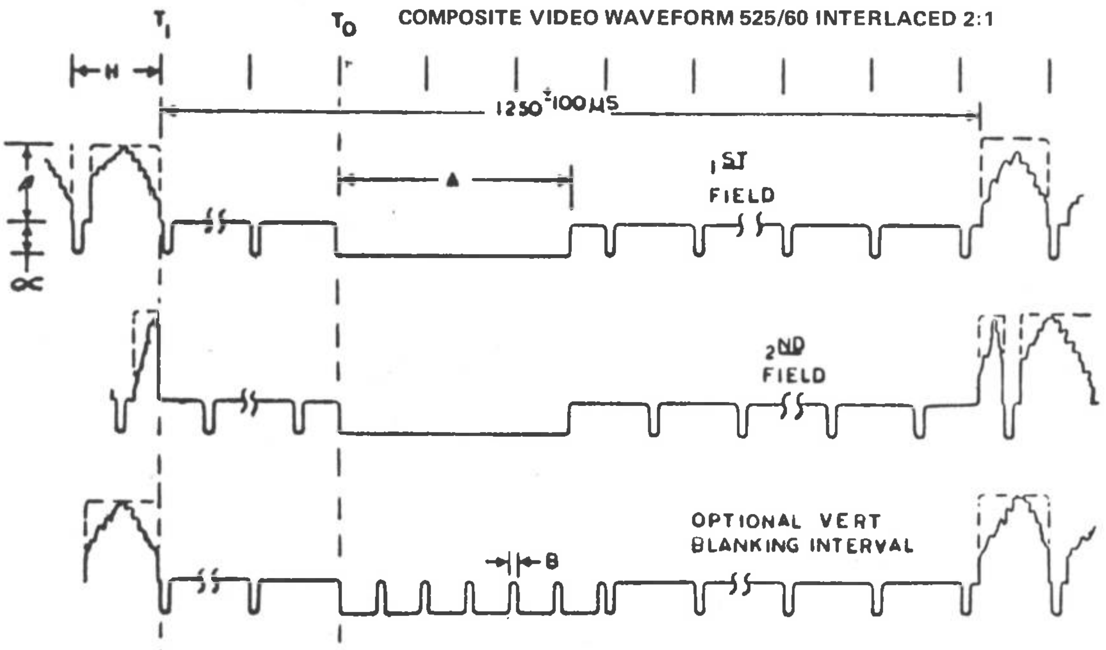
NOTE:

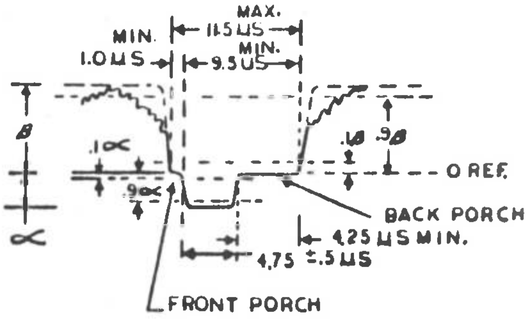
1. H = time from start of one line to start of next line.
2. V = time from start of one field to start of next field.
3. Leading and trailing edges of vertical driving and vertical blanking signals should be complete in less than 0.1H.
4. All tolerances and limits shown in this drawing are permissible only for long time variations.
5. Timing adjustment, if any shall include this condition.
6. The vertical driving pulse duration shall be 0.04V, ±0.006V. The horizontal driving pulse duration shall be 0.1H, ±0.005H.
7. The time relationship and waveform of the blanking and sync signals shall be such that their addition will result in a standard RETMA signal. The time relationship shall be adjustable in order to satsify this relationship for the condition where the blanking signal is delayed with respect to the sync signal over the range from 0.0H to 0.05H.
8. The standard RETMA values of frequency and rate of change of frequency for the horizontal components of the sync signal at the output of the picture line amplified shall also apply to the horizontal components of the output signals from the recommended sync generator.
9. All rise and decay times shall be measured between 0.1 and 0.9 amplitude reference lines.
10. The time of occurrence of the leading edge of any horizontal pulse "N" of any group of twenty horizontal pulses appearing on any of the output signals from a standard sync generator shall not differ from "NH" by more than 0.0008H where H is the average interval between the leading edges of the pulses as determined by an averaging process carried out over a period of not less than 20 nor more than 100 lines.
11. Equalizing pulse area shall be between 0.45 and 0.5 of the area of a horizontal sync pulse.
12. The overshoot on any of the pulses shall not exceed 5%.
13. The output level of the blanking signal and the sync signal shall not vary more than ±3% under the following conditions:
    - A. The ac voltage supplying the sync generator shall be in the range between 110 V and 120 V and must not vary more than ±5 V during test.
    - B. A period of 5 hours continuous operation shall be considered adequate for this measurement, after suitable warm-up.
    - C. The room ambient shall be in the range between 20° and 40° C and shall not change more than 10° C during this test.
14. Adjustment shall be possible between minimum and maximum limits so that aspect ratio can be set to the normal value.



Rise & decay times shall be equal or less than rise & decay times of hor. blanking — See note 9

Figure 8-3. EIA RS-170 Specifications

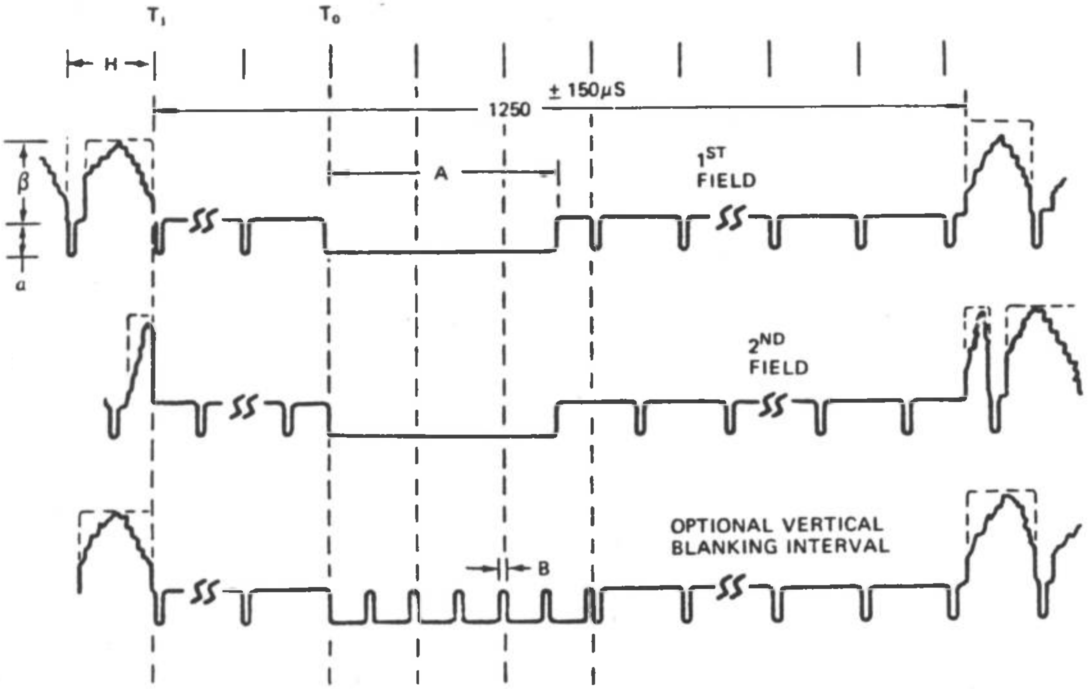

T1
T0
COMPOSITE VIDEO WAVEFORM 525/60 INTERLACED 2:1
H
1250±100 µS
A
1ST FIELD
β
α
2ND FIELD
OPTIONAL VERT BLANKING INTERVAL
B

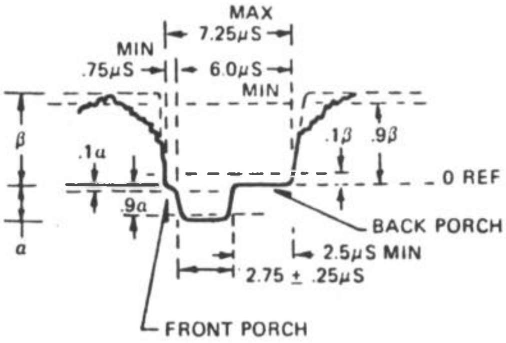


NOTES:

1. $\beta = 0.714 \pm .1$ volts (100 IRE Units).
2. $\alpha = 0.286$ (40 IRE Units) nominal.
3. Sync to total signal ratio $\left(\frac{\alpha}{\beta + \alpha}\right) = (28.6 \pm 5)$ %.
4. Blanking = 7.5 ±5 IRE Units (2.5% to 12.5% of β).
5. Horizontal Rise times measured from 10% to 90% amplitudes shall be less than 0.3 µ/s.
6. Overshoot on horizontal blanking signal shall not exceed 0.02β at beginning of front porch and 0.05β at end of back porch.
7. Overshoot on sync signal shall not exceed 0.05β.
8. T_0 = start of vertical sync pulse.
9. T_1 = start of vertical blanking.
10. $T_1 = T_0 \, {}^{+0}_{-250}$ µ/s.
11. A – vertical sync pulse = 150 ±50 µ/s measured between 90% amplitude points.
12. Rise and fall times of vertical blanking and vertical sync pulse, measured from 10% to 90% amplitudes, shall be less than 5 µ/s.
13. Tilt on vertical sync pulse shall be less than 0.1 α.
14. If horizontal information is provided during the vertical sync pulse it must be at 2H rate and as shown in the optional vertical blanking interval waveform.
15. B – vertical serration = 4.5 ±.5 µ/s measured between the 90% amplitude points. Rise times measured from 10% to 90% amplitudes shall be less than 0.3 µ/s.
16. If equalizing pulses are used in the vertical blanking interval waveform they shall be 6 in number preceding the vertical sync pulse and be at 2H rate.

Figure 8-4. EIA RS-330 Specifications





NOTES:

1. $\beta = 0.714 \pm 0.1$ volts (100 IRE Units).
2. $\alpha = 0.286$ (40 IRE Units) nominal.
3. Sync to total signal ratio $\left(\frac{\alpha}{\beta + \alpha}\right) = 28.6 \pm 5\%$.
4. Blanking = 7.5 ±5 IRE Units (2.5% to 12.5% of β).
5. Horizontal Rise Times measured from 10% to 90% amplitudes shall be less than 0.1 μ/s.
6. Overshoot on horizontal blanking signal shall not exceed 0.02β at beginning of front porch and 0.05β at end of back porch.
7. Overshoot on sync signal shall not exceed 0.05β.
8. T_0 = start of vertical sync pulse.
9. T_1 = start of vertical blanking.
10. $T_1 = T_0 \begin{matrix} +0 \\ -250 \end{matrix}$ μ/s
11. A — vertical sync pulse = 125 ±50 μ/s measured between 90% amplitude points.
12. Rise and fall times of vertical blanking and vertical sync pulse, measured from 10% to 90% amplitudes, shall be less than 5 μ/s.
13. Tilt on vertical sync pulse shall be less than 0.1 α.
14. If horizontal information is provided during the vertical sync pulse it must be at 2H frequency and as shown in the optional vertical blanking interval waveform.
15. B — vertical serration = 2 ±.5 μ/s measured between the 90% amplitude points. Rise time measured from 10% to 90% amplitudes shall be less than 0.1 μ/s.
16. If equalizing pulses are used in the vertical blanking interval waveforms they shall be 6 in number preceding and following the vertical sync pulse, be at 2H frequency and ½ the width of H sync pulse.
17. It is recommended that for proper interlace the time duration between the leading edge of vertical sync and the leading edge of horizontal sync be a multiple of H/2.

Figure 8-5. EIA RS-343-A Specifications

Rack-mount and portable cabinet CCUs are modularly constructed units of chromate coated aluminum that house electronic circuits remote from the Camera head. Circuits are solid state and contained on etched glass epoxy boards. These circuit boards have readily accessible test points and adjustments. Adjustable component and test-point identifications are silk-screened on the circuit board and front panel, where access holes for adjustments and test points are located.

8.2.1 Rack Mount Frame

The rack-mount frame fits in a standard 19-inch rack or recessed console cabinet. It requires 5.25 inches of vertical space (figure 8-6). The rack-mounting enclosure can contain two independent CCUs, one CCU and a blank filler panel for the unused position, or one CCU plus remote controls for Camera accessories, such as the reverse video polarity switch, and pan-and-tilt or motorized focus and iris controls. On the rear panel of the single rack mount frame are four BNC connectors to provide for external inputs and outputs for the sync and/or blanking generator, two BNC connectors for the video output signal, one multipin connector for the Camera-to-CCU cable, and one power cord connector. The line voltage selector switch (230 V/115 V) is also located on the rear panel. The dual-position model has two rear interface panels to provide input and outputs for both CCUs.

8.2.2 Portable Cabinet

The portable cabinet model CCU (figure 8-7) contains only one CCU. Board configuration is the same as in the rack-mount CCU. A top mounted handle provides for carrying the unit when relocation is desired. Rear panel cable connections are the same as the rack-mount version. The portable cabinet CCU can be placed on any flat surface for operation.

8.3 EQUIPMENT SUPPLIED

Figure 8-8 is a model number interpretation of the 8000 CCU. The model number both identifies the series of which an individual CCU is a part and describes differences from other CCUs of the same series.

1. Model 8000 CCU
2. Rackmount enclosure or portable cabinet
3. Ac power cord
4. Interconnect cable (section 1.3.2)

8.4 EQUIPMENT REQUIRED BUT NOT SUPPLIED

1. 8120 Camera
2. 75-ohm coaxial cable

8.5 OPTIONAL ACCESSORIES

Some of the following accessory items are likely to be required, depending on the intended application.

1. Shading board

*2. Sync generator board

*3. Blanking generator board

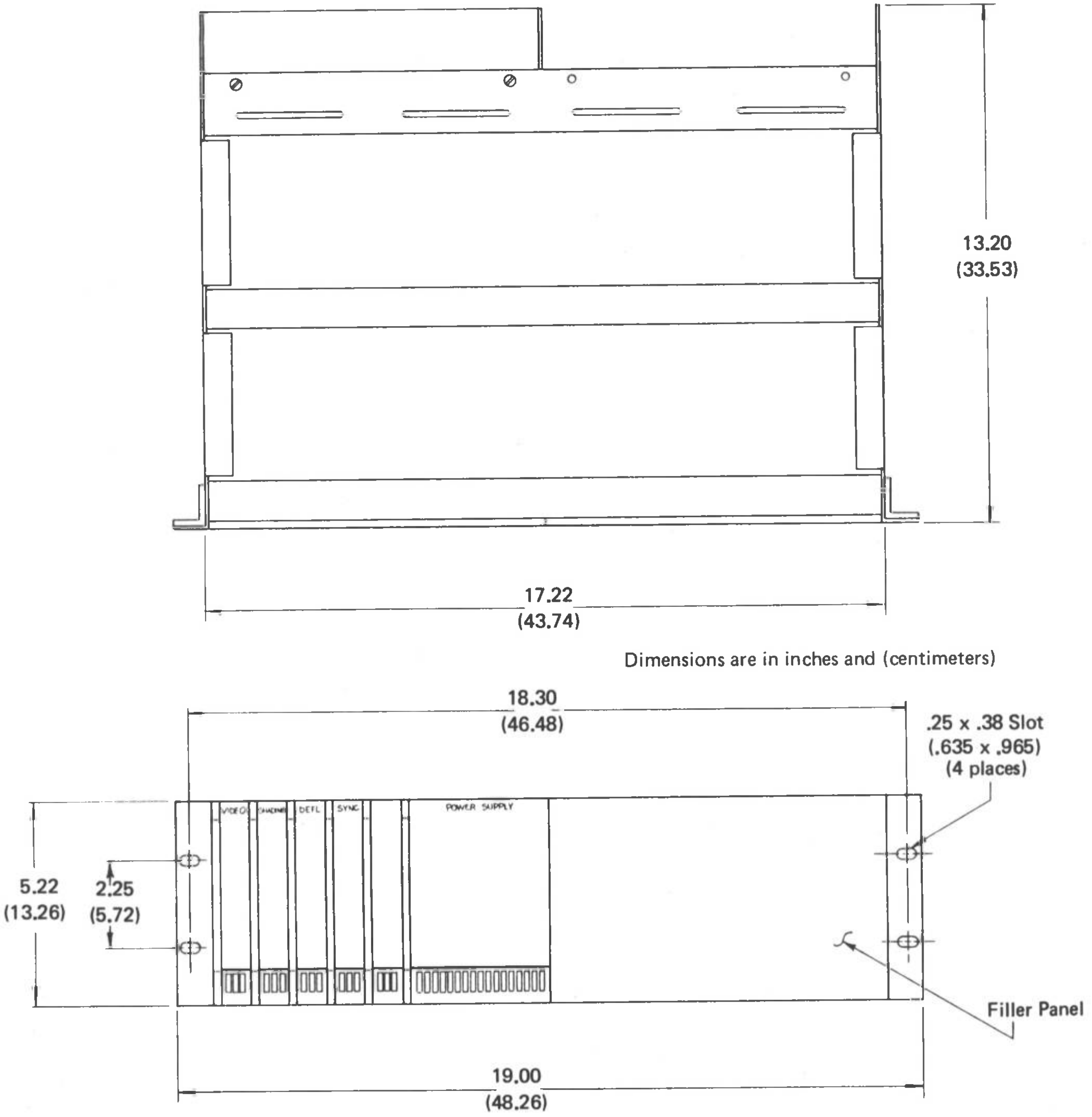
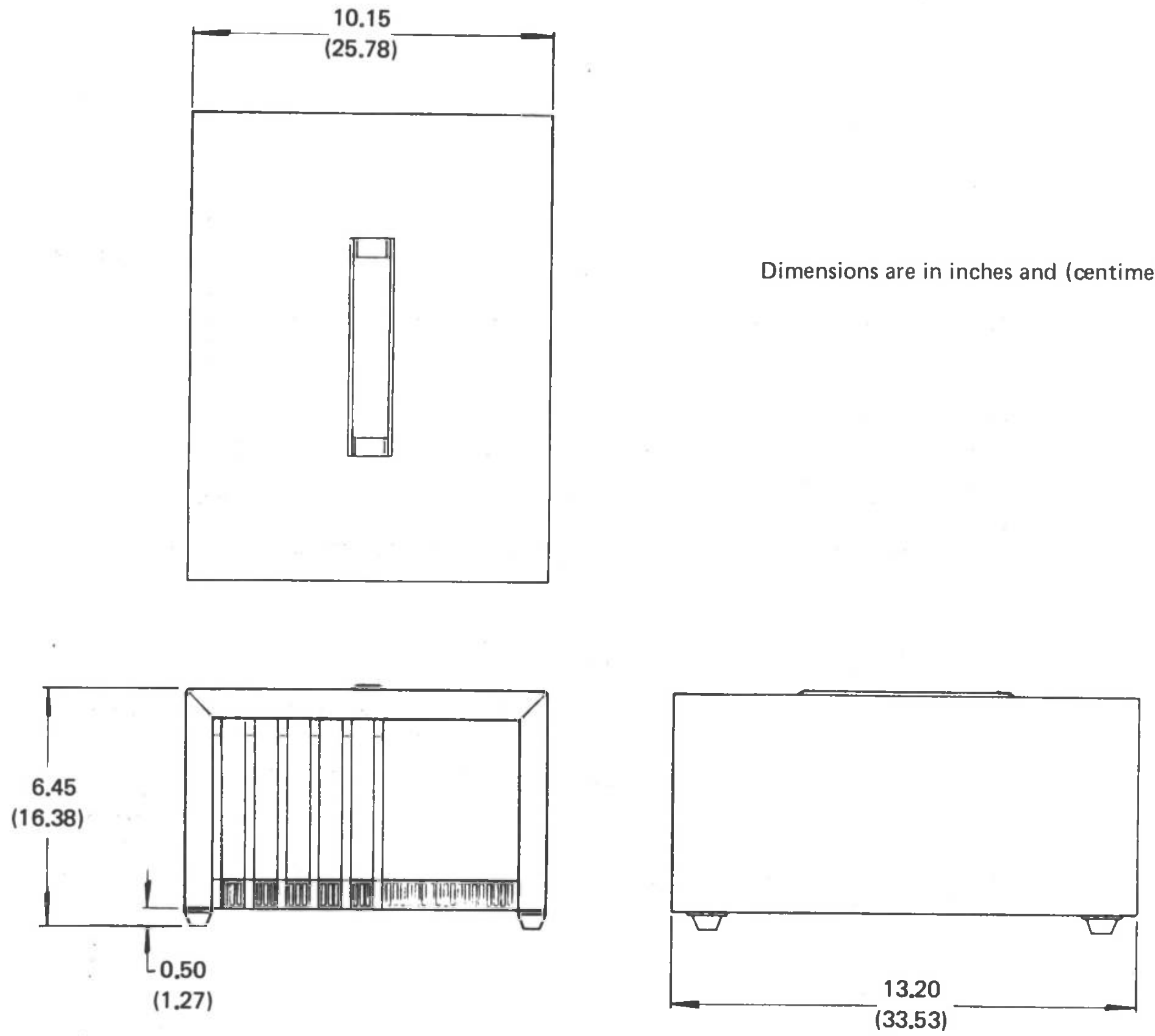


Figure 8-6. Critical Dimensions, Rack-mount

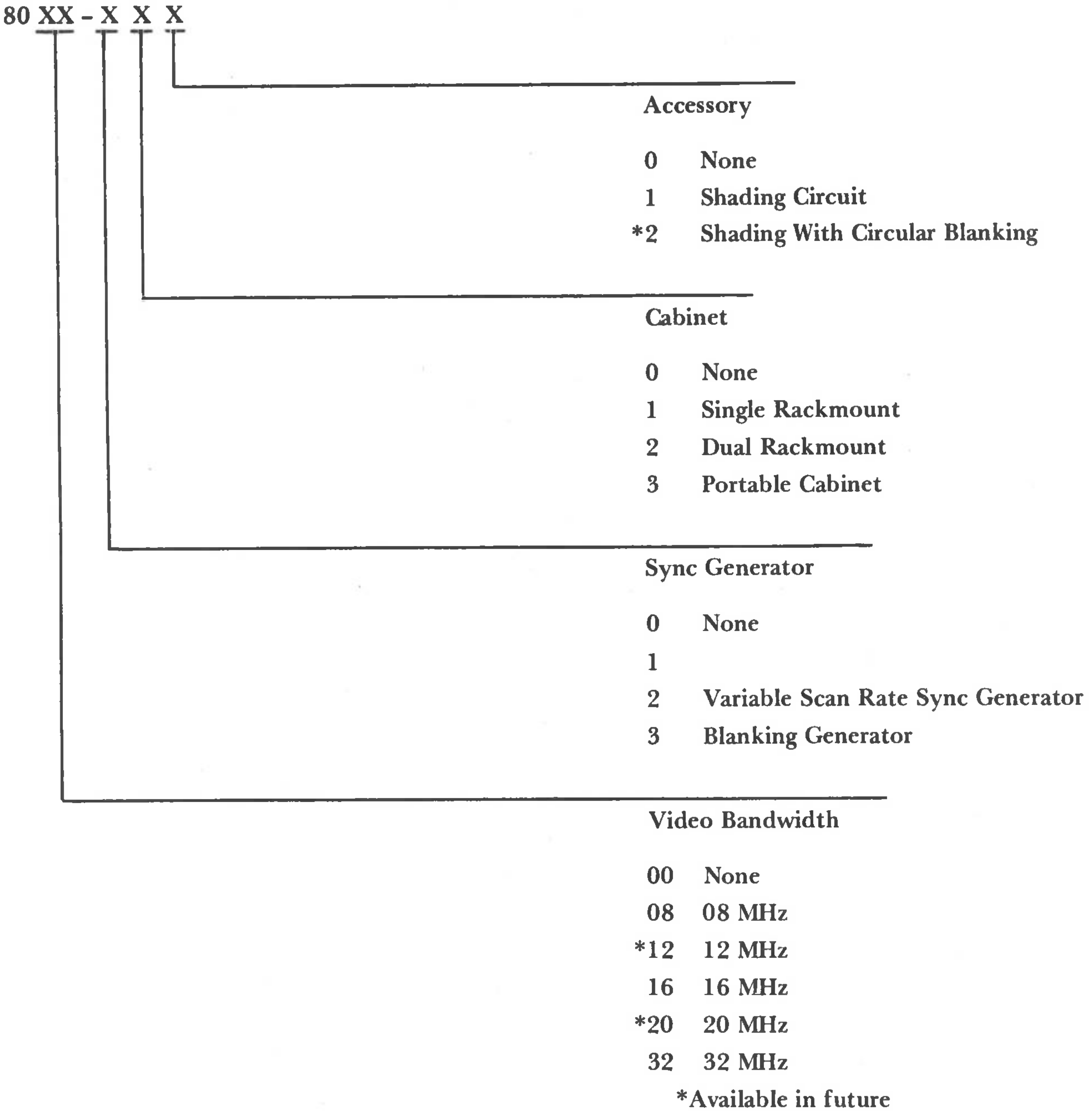
4. Reverse polarity control

* Refer to table 8-1 for possible sync and blanking generator combinations.



Dimensions are in inches and (centimeters)

Figure 8-7. Critical Dimensions, Portable Cabinet



Accessory

0	None
1	Shading Circuit
*2	Shading With Circular Blanking

Cabinet

0	None
1	Single Rackmount
2	Dual Rackmount
3	Portable Cabinet

Sync Generator

0	None
1	
2	Variable Scan Rate Sync Generator
3	Blanking Generator

Video Bandwidth

00	None
08	08 MHz
*12	12 MHz
16	16 MHz
*20	20 MHz
32	32 MHz

*Available in future

Figure 8-8. CCU Model Number Interpretation

Table 8-1. Sync and Blanking Sources

SOURCE SELECTED	OTHER SOURCES SELECTED
1. Optional sync generator board	No other sync or blanking source required.
2. Optional blanking generator board	Customer provides sync source.
3. Neither option selected	Customer provides sync and blanking source.

PART TWO – CCU

SECTION IX
INSTALLATION

9.1 RECEIVING INSPECTION

This item was thoroughly tested and carefully packed in our factory. Upon acceptance by the carrier, they assume responsibility for its safe arrival. Should you receive this item in a damaged condition, apparent or concealed, claim for damage must be made upon the carrier. Do not return the item to the factory, if required, until receiving an approval from our customer service department.

9.1.1 Apparent Damage

If upon receipt of this shipment a visual inspection shows damage, it must be noted on the freight bill or express receipt and the notation signed by the carrier's agent. Failure to do this will result in the carrier refusing to honor the claim. The carrier will furnish you with necessary forms for filing a claim.

9.1.2 Concealed Damage

When damage is not apparent until the unit is unpacked, a claim for concealed damage must be entered. When this damage is discovered, make a mail or phone request to the carrier for inspection. Keep all cartons and packing materials. You must make the request for inspection immediately upon discovery of concealed damage. Since damage is the carrier's responsibility, the carrier will furnish you with an inspection report and necessary forms for filing the concealed damage claim.

9.2 INSTALLATION

CCU installation is straightforward and should pose no particular problems. Before installing, plan the cable runs and provide for ac power.

Installation consists of:

1. Mounting at the desired location
2. Making the cable connection to the Camera
3. Connecting, if used, external sync and/or blanking generators (figure 9-1).

9.2.1 CCU Installation

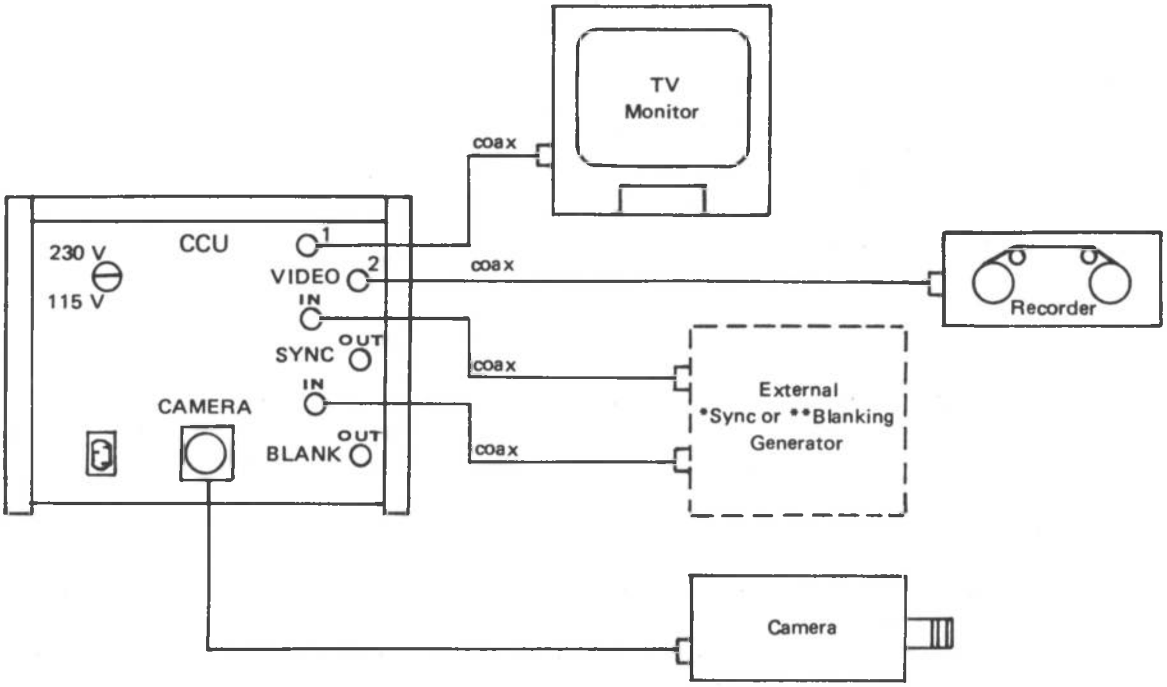
1. Install the rack-mount version of the CCU in either a standard 19-inch rack or recessed console cabinet. Set the portable cabinet version on any flat surface.

2. Connect the multiconductor cable (figure 9-2 or 9-3) from the connector located on the rear of the Camera to the connector labeled CAMERA on the rear of the CCU (figure 13-2).

3. Connect 75-ohm coaxial cables from the BNC connectors labeled VIDEO 1 and 2 on the CCU to monitors, video switchers, tape recorders, transmitter, or other equipment. Be sure that each cable terminates into 75 ohms at this equipment.

4. If external sync and blanking is to be used, connect cables from these external sync and blanking pulse sources to the BNC connectors labeled SYNC IN and BLANK IN on the CCU. Use 75-ohm coaxial cable for the connections.

5. When two or more CCUs are to be synchronized with one sync and blanking source, the instructions



NOTE:
All coaxial cables are 75 ohm, terminated with BNC connectors:
* Sync from an external source is required if camera control does not contain one of the optional sync generator plug-in units.
** Blanking from an external source is required if camera control does not contain either one of the optional sync generators or blanking generator plug-in units.

Figure 9-1. CCU Cable Connections

in steps 2 through 4 are still valid–with the following exceptions:

a. The first CCU in the chain must contain the sync/blanking plug-in board or receive external sync and blanking.

b. Remove the internally installed 75-ohm sync (R3) and blanking (R91) termination resistor located on deflection board A503 (figure 13-11) from all but the last CCU in the chain.

c. Use 75-ohm coax to connect all the SYNC OUT and BLANK OUT connectors to the SYNC IN and BLANK IN connectors of succeeding CCUs (figure 9-4).

6. Verify that the POWER switch on the front panel of the CCU is in the OFF position before attaching the power cord.

7. The Camera system operates on a voltage range of 105–130/210–260 volts ac, 50 to 60 Hz, with maximum power of 60 watts, though 40 watts is typical. Ac power is applied to a receptacle at the rear of the CCU, using a detachable power cord with three-terminal grounding connectors. Line voltage is selected by the 230/115 volt switch on the rear panel.

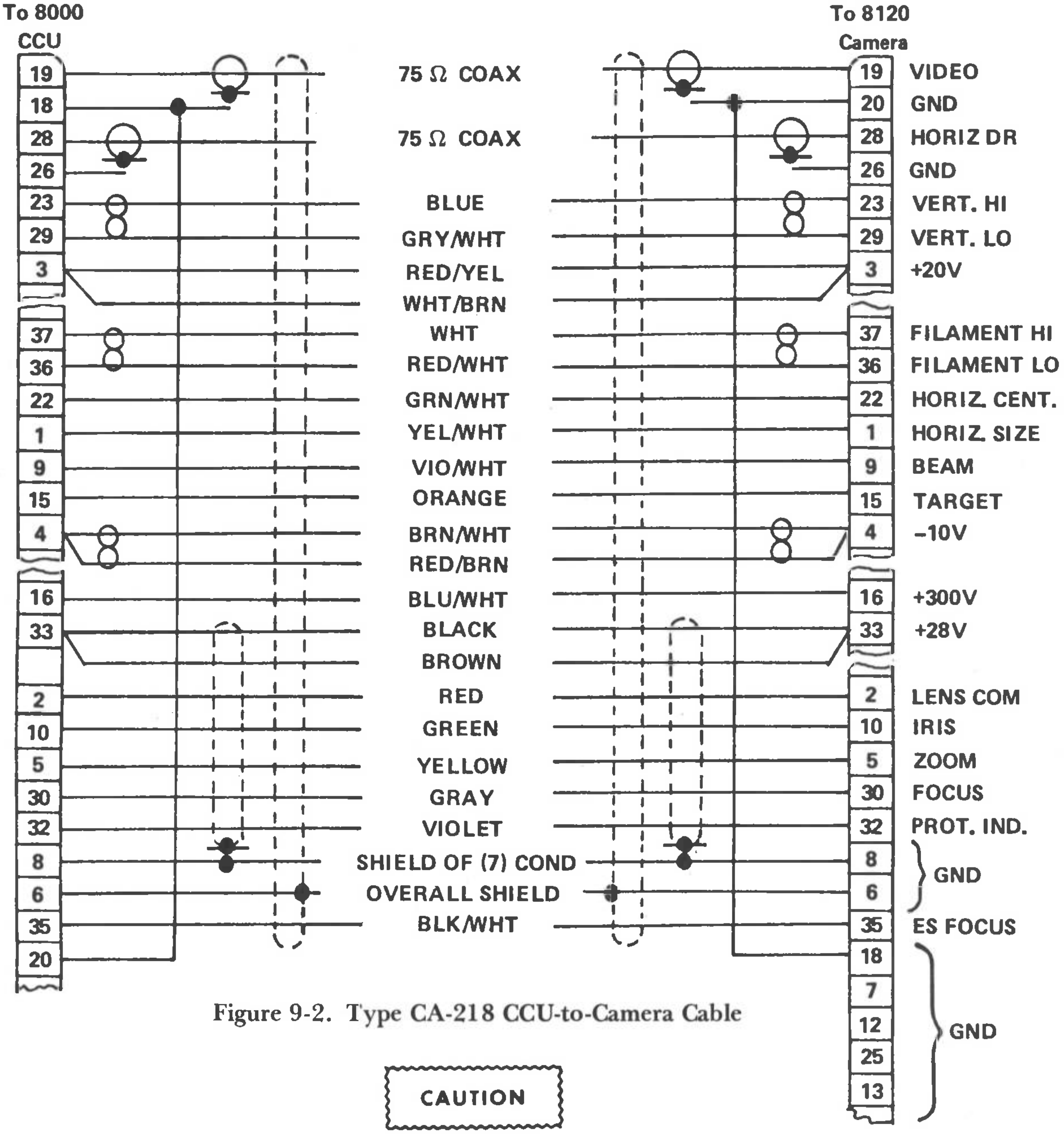


Figure 9-2. Type CA-218 CCU-to-Camera Cable

CAUTION

To avoid damage to electrical components, verify that the voltage range selection switch (230/115) is in the proper position for the line voltage to be used before applying ac power.

8. If the optional sync generator board is part of the system, set the 50/60 CYCLE jumper located on this board (figure 13-12) to match line-power frequency.

9.3 PREPARATION FOR SHIPMENT AND STORAGE

For storage periods exceeding about a month, seal the unit in a vapor-proof bag containing a fresh desiccant pack prior to packaging the unit in a sturdy box. Use sufficient foam padding or other suitable packing material to prevent damage by sudden shock loads or crushing that may occur during shipping.

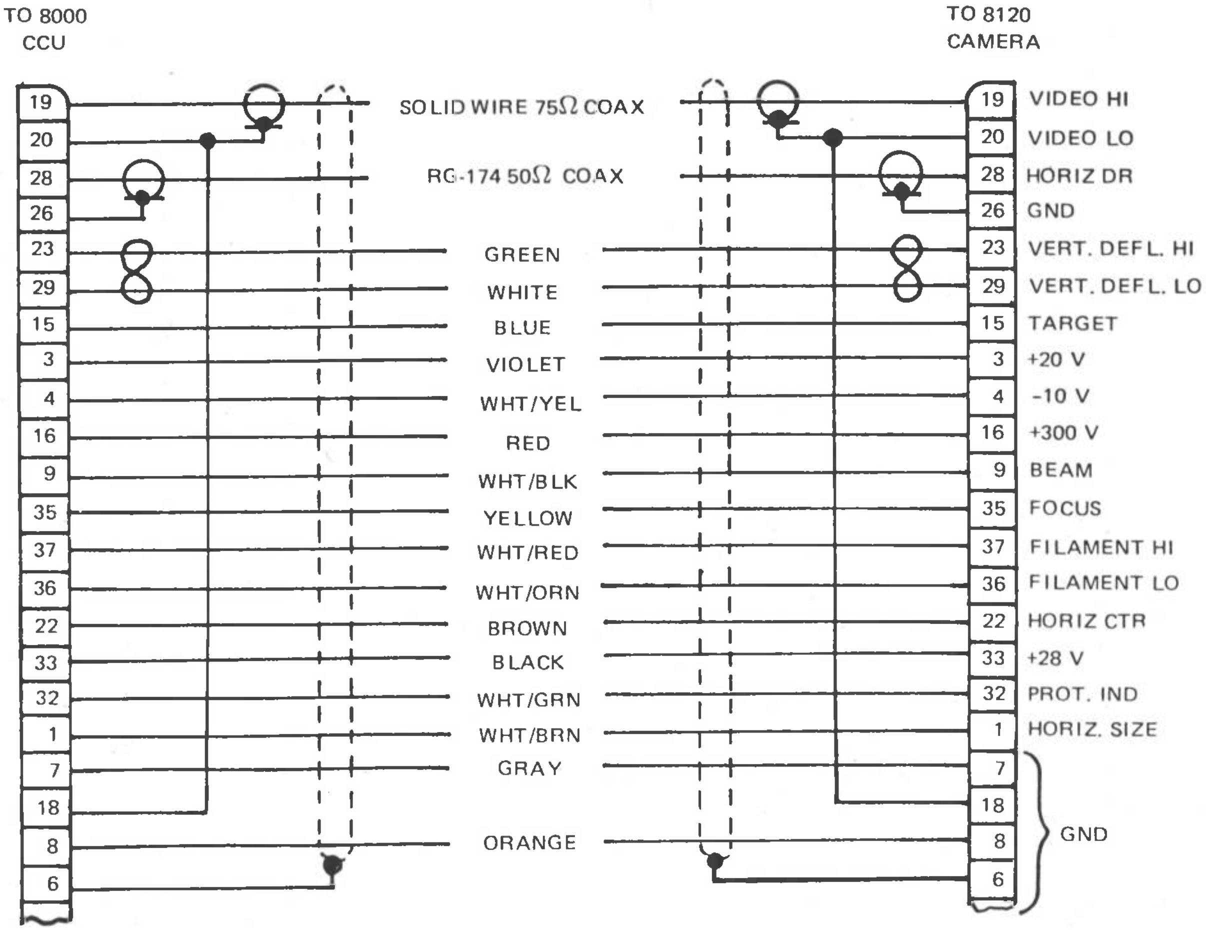
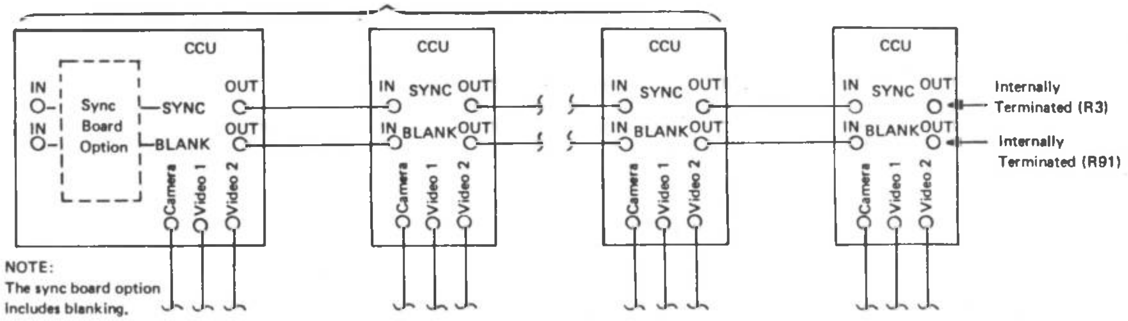


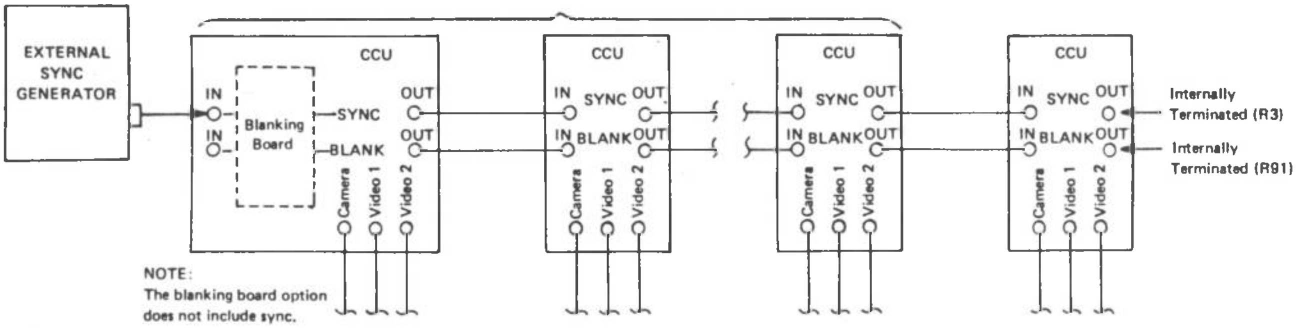
Figure 9-3. Type CA-219 Superflex CCU-to-Camera Cable

The storage environment must be maintained within -62° to +85° C with relative humidity not exceeding 90 percent (without condensation).

Plug-in sync generator board installed in first CCU. No other sync or blanking source required.
R3 and R91 removed


CCU
IN
IN
Sync Board Option
SYNC
BLANK
OUT
OUT
Camera
Video 1
Video 2
CCU
IN SYNC OUT
IN BLANK OUT
Internally Terminated (R3)
Internally Terminated (R91)
NOTE:
The sync board option includes blanking.

External sync and blanking sources provided by customer to first CCU.
R3 and R91 removed



Plug-in blanking generator board installed in first CCU. Customer must provide external sync.
R3 and R91 removed

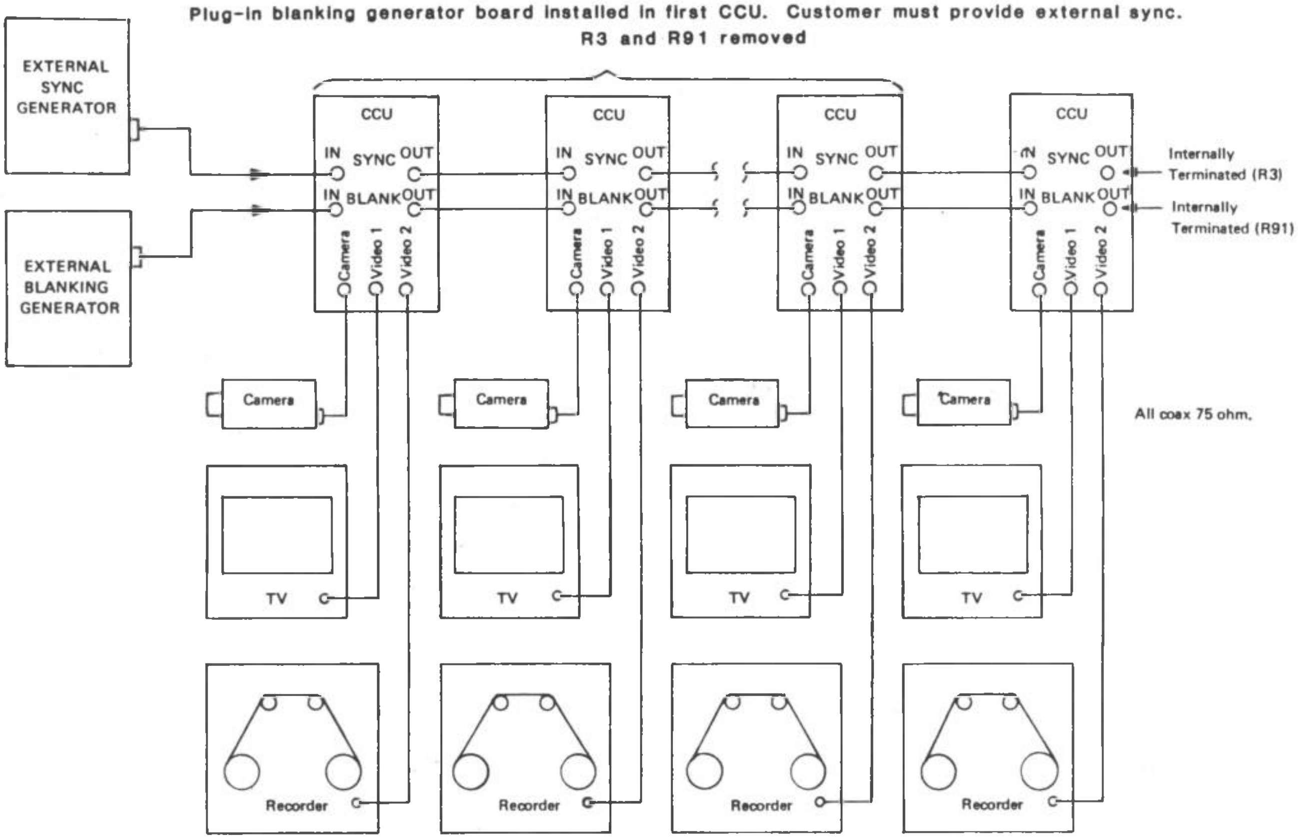


Figure 9-4. Sync and Blanking Source, Multiple CCU/Camera System

SECTION X
OPERATION

Once the Camera and CCU are installed, as described in section II and section IX, operation consists of turning on ac power and adjusting iris and focusing rings on the imaging lens mounted to the front of the Camera. All Camera functions are operated remotely from the CCU. All potentiometer adjustments on the CCU are set during maintenance procedures and should not require any further adjustment. With extreme lighting conditions, however, it may be desirable to operate in the MAN TARGET (manual) mode and make the adjustments in table 10-1.

Table 10-1. Operator Controls and Adjustments

NAME	OPERATION	FUNCTION
1. POWER ON/OFF	Set to OFF	Turns ac power off.
2. BEAM	Adjust fully ccw	Insures against tube damage when ac power is applied.
3. FOCUS	Adjust to midpoint	Rough electrical focus before ac power is applied.
4. MANUAL TARGET	Adjust fully ccw	Insures against tube damage when ac power is applied.
5. TARGET AUTO/MAN	Set to MAN	Selects manual control of light sensitivity of the Camera.
6. POWER ON/OFF	Set to ON	Turns ac power on.
7. Lens Iris	Fully open	Adjusts size of aperture to maximum.
8. BEAM	Adjust as needed until a "wiping-in" of light is seen on the tv monitor raster. Continue adjusting until light areas of the picture can be seen.	Adjusts beam current at Camera picture tube.
9. MANUAL TARGET	Adjust as needed to extinguish both VIDEO LVL indicator LEDs (OVER UNDER), located on the front panel of the CCU.	Adjusts light sensitivity of the Camera.
10. FOCUS	Adjust as needed for sharp picture on the tv screen.	Adjusts electrical focus of the scanning beam.

Repeat adjustments of the MANUAL TARGET, BEAM, FOCUS and iris to obtain the best possible picture and to extinguish both VIDEO LVL indicator LEDs (OVER/UNDER).

10.1 OPERATING PROCEDURE

To operate the Camera and CCU proceed as follows:

1. Aim the Camera at the scene to be televised.
2. Set the lens focus ring for the distance separating Camera from scene (refer to section 3.1 and section 5.4.2 for Camera operation and focusing instructions).

3. Select a lens aperture appropriate for the illumination on the scene.
4. Set the TARGET AUTO/MAN switch to AUTO (figure 10-1).

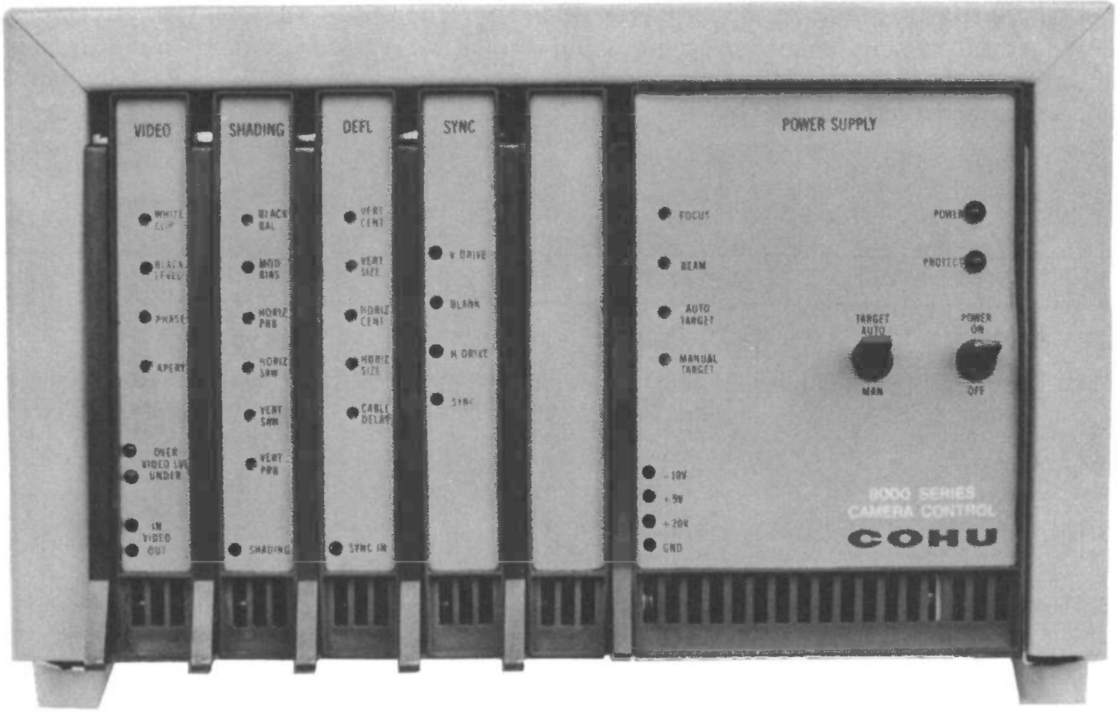


Figure 10-1. Front Panel Operator Controls

5. Set the POWER ON/OFF switch to ON.
6. Readjust the lens focus ring for the sharpest possible picture.
7. If necessary readjust the lens aperture to extinguish the VIDEO LVL OVER/UNDER LEDs located on the video board front panel.

PART TWO – CCU

SECTION XI
CIRCUIT DESCRIPTION

Circuit descriptions for the CCU appear in this section. A general description precedes detailed discussions of circuit operation. Circuit descriptions are divided into six sections:

- video board (A501)
- *shading board (A502)
- deflection board (A503)
- * *sync generator board (A504-1)
- * *blanking generator board (A504-2)
- power supply assembly (A506)

*Optional
* *Optional (either a sync or a blanking board may be used, but not both).

Individual transistors in transistor array packages are identified by their emitter pin number. With IC packages such as dual operational amplifiers, stages are identified by their output pin number. Schematic diagrams are in section 14.

11.1 VIDEO BOARD (A501)

The video board amplifies the video signal received from the Camera, provides aperture and gamma corrections, compensates for cable transmissions losses, re-establishes a black-reference level, and adds sync and blanking to the signal. For descriptive purposes the video processor circuits can be broken down into the sections indicated in figure 11-1.

Video signals from the Camera enter the video processor at terminal 15 (table 11-1). The signal is transferred through a low-pass filter and cable compensation network. All of the components in the filter are installed on a small etched-circuit board that plugs into three terminals on the video board. The cable compensator equalizes the video for high-frequency rolloff resulting from distributed capacitances in the Camera-to-CCU interconnecting cables and input wiring. Component values in the filter vary with system bandwidth, as shown in table II of the video schematic.

The video signal appearing at the cable compensator is amplified by the input gain circuit (U1) to bring it up to a level of about 1 V p-p. To eliminate smear and streaking due to the relative time delay of some parts of the video signal with respects to others, higher frequencies are shifted in phase from 0° to 180° . The aperture corrector enhance Camera performance by sharpening the edges of picture details that have been softened by the finite spot size of the scanning beam where it strikes the target. Higher frequency components of the original video signal and phase shifted video are summed in the aperture correct circuit to provide a video signal with controlled amounts of higher frequencies, phase correction, and peaking. The video signal is then clamped to the white-peak clipper. White peaks of the video signal are clipped when they reach about 2 volts. This has the effect of reducing brightness in the highlights so other picture details can show up more clearly. During horizontal- and vertical-blanking intervals, the video signal is clamped to ground via the blanking circuit. This removes spurious signals generated by retrace of the scanning beam at the Camera and provides a fixed dc setup level through the auto-black circuit, which has its output coupled back to the clamp input.

Since picture tubes compress video information near black level, resulting in pictures that have no natural grey scale, a nonlinear amplifier technique called gamma correction is employed at the Camera. The circuit for this expands the darker areas of the video signal. Picture details in the darker areas of the scene then show up more clearly. A polarity reversal circuit on some versions provides for the composite video signal being reversed in polarity at the output stage when desired. If the reverse polarity feature is not included, video signal bypasses this circuit via jumpers. Blanking is added to the video signal, and common mode rejection is provided.

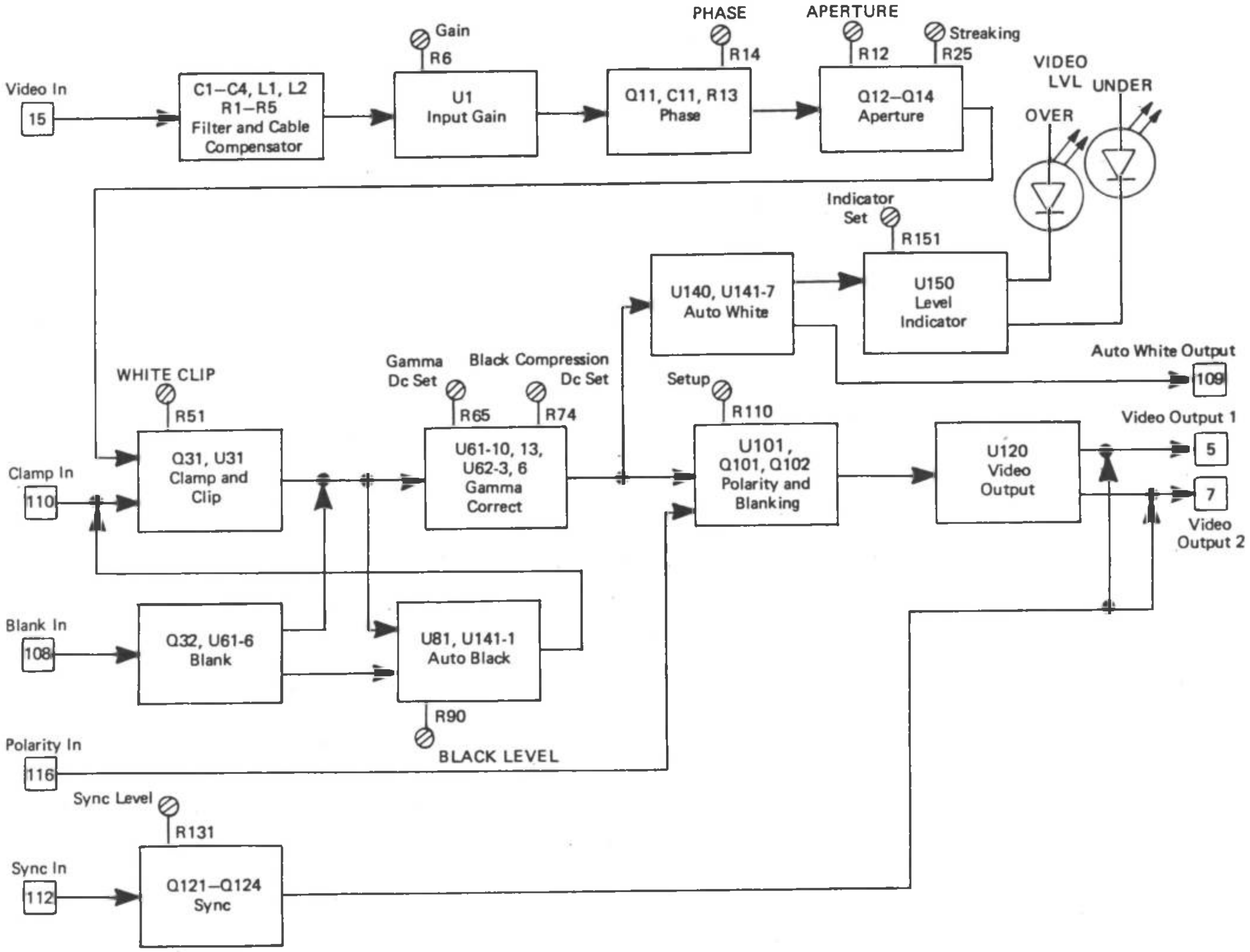


Figure 11-1. Functional Diagram, Video Board (A501)

The auto-white stage detects positive peaks of the video signal and provides a low-impedance dc output equivalent to their level. The output on terminal 109 goes to the auto-target circuit located on the power supply board (A506A1).

Two level-indicator LEDs, one for over-video and the other for under-video, light when positive peaks from the auto-white stage are above or below the level established by a potentiometer (R151).

After the polarity and blanking stage, video signal is coupled to the video output jacks on the rear of the CCU. Output dc level is controlled by jumper selection for 1.5 or 1.0 V p-p. Sync pulses are added to the two video output lines.

11.1.1 Lowpass Filter and Cable Compensator

Video signal from the Camera is received on the video board at terminal 15. It is white-negative in polarity and has a nominal peak-to-peak amplitude of 200 millivolts. From terminal 15 the signal is transferred through a lowpass filter and cable compensation network.

The lowpass filter (figure 14-2) is an LC network with a response filter flat within ±0.5 dB to near 32 MHz and 3 dB down at that frequency. Above this cutoff frequency, the filter rolloff characteristic is 100 dB per decade. All filter components are installed on a small etched-circuit board that plugs into three terminals on the video board (A501).

Table 11-1. Inputs and Outputs, Video Board (A501)

INPUT POWER	+20 V dc (terminal 2) -10 V dc (terminal 17)
INPUT SIGNALS	
Video (terminal 15)	White-negative: 200 mV p-p nominal
Clamp In (terminal 110)	Positive-going 10 V p-p pulse occuring at horizontal-scan rate. Pulse width approximately 1.5 μs.
Shading In (terminal 106)	Composite signal of horizontal and vertical sawtooth and parabolic waveforms from the optional shading board (A502). Amplitude adjustable from shading board.
Dc In (terminal 105)	Adjustable dc drive voltage from optional shading board (A502).
Blanking In (terminal 108)	Negative-going pulse, nominal amplitude of 4 V p-p occuring at horizontal-scan rate. Pulse width approximately 1.3 μs.
Sync In (terminal 112)	Negative-going 4 V p-p occuring at the vertical rate.
OUTPUT SIGNALS	
Video (terminals 5 and 7)	Selectable 0.7 or 1.5 V p-p noncomposite; 1 or 2 V p-p composite.
Auto White (terminal 109)	Average dc value of video supplied to auto target circuit.

The filter is terminated with a resistive pi-network that has its series element capacitively bridged to provide equalization for the CCU video input. The basic pi-network consists of resistors R2, R4 and R5. The series element (R4) is bridged by capacitor C4 (and R3 with certain conditions). This capacitive element allows the higher video frequencies to pass with less attenuation. This compensates for losses to these higher frequencies resulting from distributed shunt capacitances in the CCU input and in the interconnection cable between the CCU and the Camera. Component values in this network vary with cable length.

11.1.2 Input Gain

The video signal appearing at the output of the cable compensator is amplified by U1 to bring it up to a level of about 1 V p-p. This integrated circuit is a differential amplifier set for a gain of approximately five with gain control R6.

11.1.3 Phase Shifter

Amplified signal from U1 drives a 180° phase shifter formed with transistor Q11, which operates as a phase splitter with a half-lattice network (C11, R13, R14) connected between its two opposing polarity outputs. High frequencies in the video signal are shifted in phase by certain amounts within the range 0° to 180°, as determined by the setting of R14. This phase shift equalizes delay to improve video transient response.

11.1.4 Aperture Corrector

The aperture corrector (Q12, Q13, Q14) enhance Camera performance by sharpening the edges of picture details that have been softened by the finite spot size of the scanning beam where it strikes the target. The circuit is driven at the base of Q12 with the video signal from the phase shifter Q11 and at the base of Q14 with the video signal that was altered in phase.

Tuned amplifier Q12 has a collector load that is adjusted with L11 to resonate with distributed capacities at 30 MHz in this 32-MHz bandwidth system.

The signal at the output of Q12, therefore, contains only the higher frequency components of the original video signal. At Q13 and Q14, a summing amplifier, these high frequency components are added via Q13 to the phase-shifted video signal that is added to Q14 to provide a video signal with controlled amounts of higher frequency phase correction and peaking. In effect, this speeds up the transient response of the system, thereby improving resolution of fine details in the picture. The amount of high-frequency peaking provided is determined by the setting of aperture control R12, a signal attenuator.

At the output of the aperture corrector, a second high-frequency peaker (R25, C18) provides additional gain (set with R25) to correct for black streaking in the video signal.

The modified video signal drives buffer amplifier Q15. It in turn drives the dark current and clamp circuit described in the next section.

11.1.5 Clamp, Clip, and Blanking

Transistors U31-12 and U31-8 operate together as a buffer amplifier with high input impedance. They couple video signal to the white-peak clipper. At U31-13 the video signal has an amplitude of about 2 V p-p.

On white peaks of the video signal, transistors U31-4 and U31-11 conduct to clip the signal. Potentiometer R51 sets this clipping to start when the amplitude of the signal reaches about 2 volts. It has the effect of reducing brightness in the highlights so other picture details show up more clearly.

During horizontal- and vertical-blanking internvals, transistor U61-8 is held in saturation by amplifier Q32, which receives a negative-going composite blanking pulse from board terminal 108. While the transistors are conducting, the video line at U61-8 is clamped to ground. This removes spurious signals generated by retrace of the scanning beam at the Camera and provides a fixed dc setup level.

11.1.6 Shading

Signal from the shading board option (A502) enters terminal 106 and routes through R44 to Q33. Shading modulator Q33 uses this signal to compensate for nonscene dependent signals generated as a result of imperfections in the optics and on the surface of the vidicon target in the Camera. The remedial technique equalizes such signals by superimposing combinations of sawtooth and parabolic waveforms on the video signal at the line and field rates. If the optional shading board is not used, the modulator is disconnected from the video circuits by moving a jumper at R47 to R49.

Variations in amplitude of shading waveforms at the gate of Q33 cause corresponding variations in source-to-drain resistance in this FET. These resistance variations change the ac impedance to ground seen by the video signal. This, in turn, varies the signal current and, therefore, the signal voltage drop across R45, thereby amplitude modulating the video signal. A dc voltage is added to the shading waveform from a potentiometer on the shading board to set the amount of amplitude modulation available. A dc voltage also is applied to the drain of Q33, via pin 105, from another potentiometer on the shading board to set the levels of the video signal that will not be modulated.

11.1.7 Gamma

A gamma of 0.5, 1, or 1.3 is jumper selectable in the gamma circuit. When the jumper is installed in the position for a normal gamma of 1, resistor R69 forms a resistive divider with R66 in the video line. This sets up a flat video response for all levels of signal at this point.

With the jumper installed in the 0.5 position, transistor U61-11 is turned on by higher level (more positive video signals). The video response is changed from linear to one with rolloff at higher signal levels.

The amount of this rolloff, and thus the shape of the video response, is controlled by potentiometer R65 in the base circuit of transistor U61-12. Conduction this potentiometer establishes through the transistor determines voltage level at R67.

Transistor U61-11 cannot conduct until its base voltage is about 0.6 volt more positive than transmitter voltage setup by R67. This base voltage is derived from the video line. So by setting the base circuit potentiometer of U61-12 the video level required in the base circuit of the video rolloff transistor is controlled.

With the jumper installed in the 1.3 position, the video line is connected into a circuit that leaves the higher video levels (whites) unaffected but compresses the lower video levels (blacks). Video signal is connected into the emitter of transistor U62-4. Higher level (more positive) voltages appearing at this emitter turn the transistor off. The video is unaffected. But as the video level approaches black levels, the transitor turns on and begins to move emitter voltage toward the collector voltage. Thus, the video-line black-level signals are prevented from decreasing fully by the slight positive bias being coupled in through the transistor. Instead of a linear video response, the response at low video (black) levels is compressed.

The amount of compression is controlled by potentiometer R74. It establishes conduction through transistor U62-8. This sets base voltage for transistor U62-4 by virtue of voltage drop across R72. Video levels applied to the emitter that are less positive than this base voltage tend to turn the transistor on. Video levels that approach the base voltage (to within less than about 0.5 volts) turn the transistor off. Turning it off removes its effect from the video line.

11.1.8 Auto Black

Operational amplifiers U81 and U141-1 make up the black-level stage. Video couples into the stage through R81. The video is first inverted then rectified to obtain the average dc level. Coupled back to the emitter of clamp transistor Q31, this dc level shifts the video level in the opposite direction to that sensed by R81 at the black-level input.

Operational amplifier U81 receives the video on its inverting input. On the noninverting input is applied 0.28 volts from the resistive divider. This voltage slews the output positive so it remains above zero volts with video applied on the inverting input. Diode CR81 rectifies the video and applies a positive voltage to RC network R89, C83. This voltage is amplified by operational amplifier U141-1 and applied back to clamp transistor Q31. Potentiometer R90 sets up the output for a nominal 650 mV p-p.

Blanking is applied to the auto black stage. Inverted blanking pulses from Q32 go positive to about +8 volts. Applied through R82 to the inverting input of U81, they force the output negative. This reverse biases the rectifying diode, isolating the RC circuit so its only discharge path is through the noninverting input of U141, a very high input impedance. It contributes little additional discharge to the RC time constant of 2.2 seconds. Thus the average dc level of the video line is preserved during blanking to maintain dc level back at clamp transistor Q31. Potentiometer R90 controls the nominal output voltage by applying positive voltage to the inverting input. The output can be slewed in the negative direction to counteract any excessive positive influence from the noniverting input, which receives video-related voltage.

11.1.9 Blanking

Blanking and the reverse polarity feature take place in stages Q101, Q102, U101-12 and U101-15. With jumpers in the normal (noninverting) position, video passes to the base of transistor U101-12. With this signal path, the base of its paired transistor is set up for dc level by potentiometer R110.

If, say, positive-going video enters the base of transistor U101-12, it increases conduction, and positive-going video is also developed across resistor R106. This positive-going signal applied to the emitter of U101-15 reduces its conduction because the emitter voltage is moving toward the base voltage. This reduced conduction through U101-15 produces less voltage drop across its collector resistor. The collector voltage increase. From this it is apparent that signals passing through these two transistors in this manner do not have their polarity reversed.

Polarity will be reversed, though, if the two jumpers are positioned 8 to 4 and 9 to 13 to change the video signal path. Video then passes through to the base of transistor U101-15. The positive-going voltage applied to the base of this transistor increase its conduction. This reduces its collector voltage. So for a positive-going video signal at the base, a negative-going video signal appears at the collector. Polarity has been reversed. To maintain the proper dc level during this reversed video condition, potentiometer R103 is connected into the base circuit of U101-12.

Video developed across R105 (either normal or inverted polarity) drives the bootstrapped pair of transistors, Q101 and Q102. This configuration minimizes loading of the collector stage and provides significant current gain for driving transistor U101-4.

Resistor R108 provides negative feedback to the base of transistor U101-15. This establishes the gain of U101-15, Q101, and Q102. In the case of noninverted video, when U101-15 is driven at its emitter, a signal of the same polarity applied to the base has the opposite effect–thus negative feedback. With the inverted video condition, when U101-15 is driven at its base, a signal coupled back here again provides negative feedback. This results because the collector signal is inverted–and the feedback resistor derives its signal from that collector circuit (through Q101 and Q102).

Blanking couples through R109 to the base of transistor U101-15. This blanking is an 8 volt positive-going pulse. It places the transistor into saturation. Transistors Q101 and Q102 turn off. The reduced conduction through R112, then, establishes voltage on the video line at about 0 to 53 mV, thereby providing blanking.

Video from the emitter of Q102 drives the base of U101-4. This transistor operates with U101-11 to form a differential amplifier. A differential amplifier only amplifies signals not common to each of its two stages. Thus noise, power supply coupling, and other sources of common signals are eliminated. Common-mode rejection is provided. Since the base of one-half of the differential amplifier is tied to ground (zero volts), only the video signal applied to the other base is passed through to U101-8.

Transistor U101-8 is driven at its emitter, and output is taken from its collector. This collector signal provides negative feedback to the base and drives the positive input of operational amplifier U120 in the output section. Capacitor C101 provides additional signal coupling for higher frequencies to maintain the video response.

11.1.10 Output Circuit

Operational amplifier U120 provides output drive to two 75-ohm resistors that establish impedance of the two video lines. This stage receives video signal on its positive input. Stage gain is established in the negative feedback path. Resistor R124 in conjunction with R121 and R122 determine this feedback and thus output level. Paralleling R122 with a jumper establishes a 1.5-V p-p output. Without this jumper, a 1-V p-p level is established. Additional feedback for high frequency stabilization is provided by C124. This rolloff of higher frequencies at this stage is not detrimental because of the high-frequency boost provided to the video input of U120 by C101.

11.1.11 Sync Inserter

This circuit is composed of transistors Q121 to Q124. Sync pulses received at board terminal 112 are inverted by Q124. The inverted pulses cause Q121 and Q122 to conduct, thereby clamping the two video output lines to a dc level established at the collectors by the current flow from Q123, as set with Sync Level control R131.

11.1.12 Auto-White Stage

The auto-white stage detects positive peaks of the video signal and provides a low-impedance dc output equivalent to their level. To do this, video is coupled through R140 to the positive input of operational amplifier U140. Stage gain is established in the negative feedback path. Resistors R141 and R142 determine output level. The amplified video is rectified by diode CR140 and the resitor-capacitor combination of R144, C143. The capacitor charges to peak level of video. Resistor R144 provides a discharge path with a time constant of 100 milliseconds. Current discharge through operational amplifier U140 and the two inputs of U150 in the level indicator stage is negligible.

The white-peak level of video is transfered to output terminal 109 of the circuit board by unity-gain amplifier U141. Impedance at this output is very low.

11.1.13 Level Indicator

The level-indicator circuit consists of the two stages of operational amplifier U150. Peak video level from the detector couples into the negative input of the over-voltage stage and into the positive input of the under-voltage stage. The opposite-polarity inputs of these two stages are biased by reference voltages. They bracket the desired video level when indicator-set potentiometer R151 calibrates the stage.

Video voltages being too positive slews the output of U150-1 to the -10 volt rail. This lights over-video LED indicator CR151.

Video voltage that is too low allows the negative input of the under-level operational amplifier to have control, slewing the output negative to light the related LED. When video voltage becomes sufficiently positive, the positive input voltage level exceeds the fixed input level, and the output slews positive. This reverse biases the LED and it extinguishes.

11.2 SHADING BOARD (A502)

The shading board option compensates for nonscene dependent signals generated at the Camera while the scanning beam in the image tube is tracing. These undesired signals result from beam-landing errors and from light loss in the optics. Since interference patterns produced in a televised scene from these spurious signals are repetitive, they can be eliminated by superimposing compensating combinations of sawtooth and parabolic waveforms on the video signal at line and field rates. A functional diagram of the circuits is shown in figure 11-2. Input and output voltages are described in table 11-2.

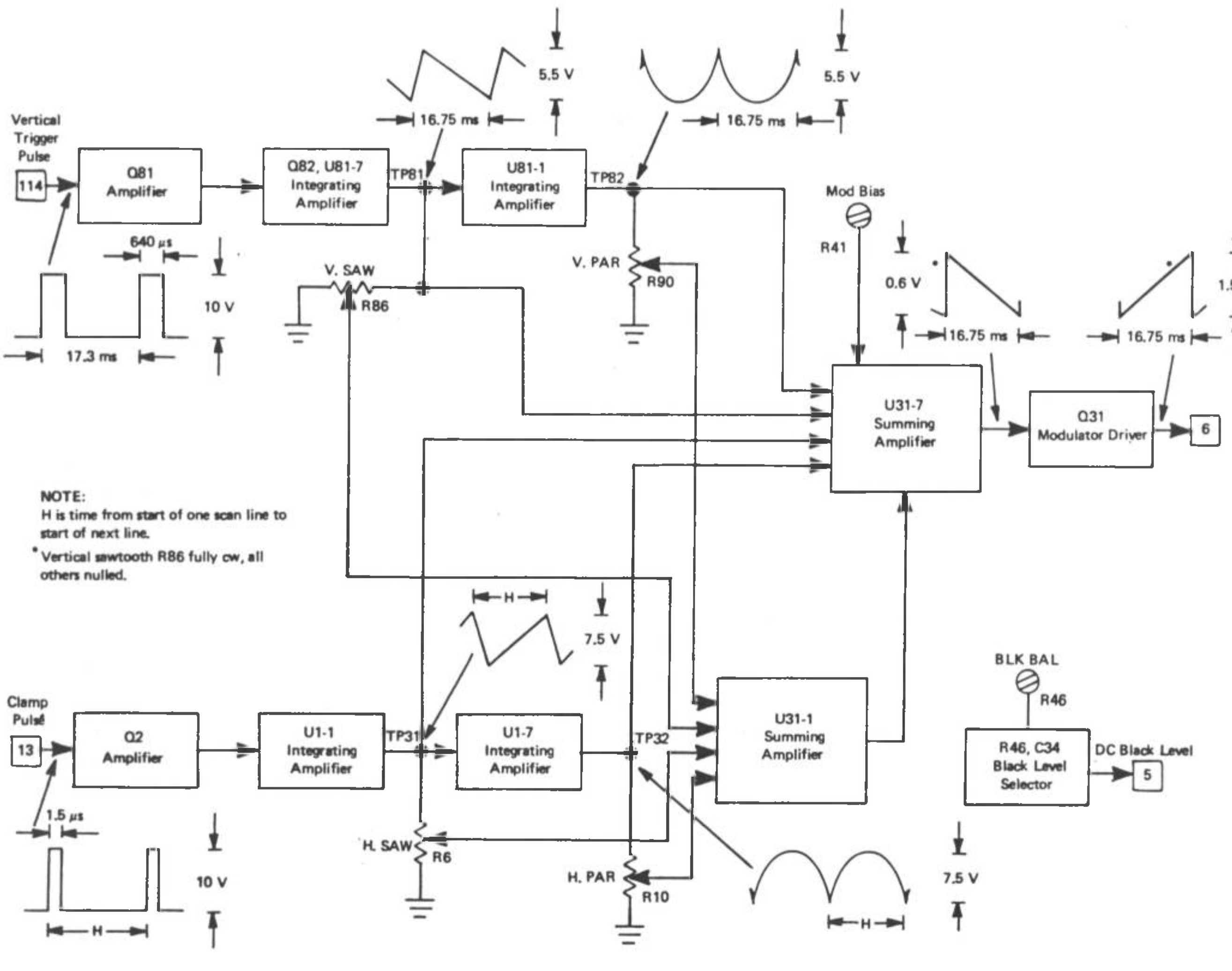


Figure 11-2. Functional Diagram, Shading Board (A502)

Table 11-2. Inputs and Outputs, Shading Board (A502)

INPUT POWER	+20 V dc (terminal 102) -10 V dc (terminal 17)
INPUT SIGNALS	
Clamp (terminal 13)	Positive-going 10 V p-p pulse occuring at the horizontal-scan rate. Pulse width approximately 1.5 μs.
Vertical Trigger (terminal 114)	Positive-going 10 V p-p pulse occuring approximately every 16.75 ms. Pulse width about 640 μs.
OUTPUT SIGNALS	
Shading Out (terminal 6)	Composite signal of horizontal and vertical sawtooth and parabolic waveforms. Amplitude is adjustable.
Dc Out (terminal 5)	Adjustable dc voltage from -10 V to +20 V.

Figure 11-3 is a simplified portion of functional diagram figure 11-2. This simplified version illustrates how potentiometers in an inverted signal path control gain of generated waveforms. Four waveforms are generated: horizontal and vertical sawtooths and parabolas. Each waveform takes two signal paths.

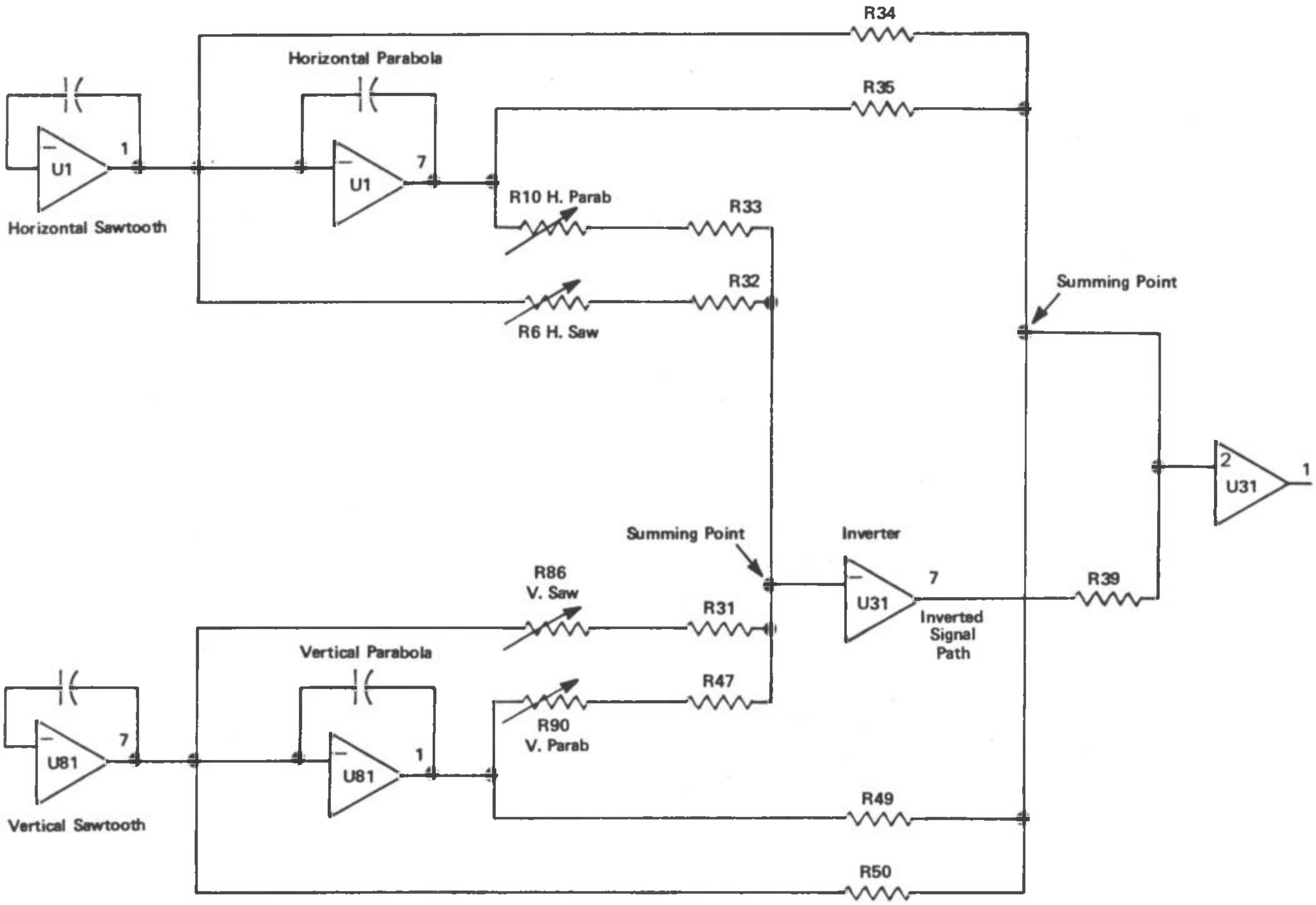


Figure 11-3. Simplified Diagram, Shading Board (A502)

In a noninverted signal path, the four waveforms sum through resistors R34, R35, R49, and R50 to input pin 2 of operational amplifier U31.

The four waveforms that are generated also pass through four potentiometers and are summed by R33, R32, R31, and R47 at the inverting input of operational amplifier U31-7. These inverted signals out of U31-7 are summed through R39 with the noninverted waveform applied to input pin 2 of U31-1.

If the gain for a waveform is identical in both its signal paths, it will not appear at the output of U31-1. They cancel each other. Thus a waveform can be nulled out by adjusting its potentiometer in the inverting signal path to exactly cancel the signal in the noninverting signal path. To increase the waveform level, the potentiometer is adjusted so that gain in its signal path is reduced. The reduced level does not completely cancel the signal level in the other signal path. The amount of signal not canceled establishes the output level of that waveform.

The output of U31-1, then, could have one, two, three, or four waveforms present. The level of each one would vary from zero to full-gain, depending on the setting of its related potentiometer.

11.2.1 Horizontal Generator

Transistor Q2 (figure 14-3) amplifies and inverts a clamp pulse received at board terminal 13. The inverted pulse drives integrating amplifier U1-1, which generates a sawtooth waveform by charging C3 at a slow rate and discharging it at a fast rate. The horizontal-rate parabolic waveform is developed by charging and discharging C5 at an exponential rate with integrated amplifier U1-7, which is driven by the sawtooth waveform generated by C3 and U1-1.

11.2.2 Vertical Generator

The vertical-rate sawtooth waveform is generated by first inverting and amplifying at Q81 a vertical-trigger pulse waveform received at board terminal 114. The inverted pulse then drives Q82 at integrating amplifier U81-7. This operational amplifier generates a sawtooth by charging C82 at a slow rate. Transistor Q82 discharges it at a faster rate.

The vertical-rate parabolic waveform is developed by charging and discharging C84 at an exponential rate with integrated amplifier U81-1, which is driven by the vertical-rate sawtooth waveform.

11.2.3 Shading Mixer

The generated vertical- and horizontal-rate sawtooth and parabolic waveform at C3, C5, C82, and C84 route through summing resistors R34, R35, R50, and R49 to input pin 2 of operational amplifier U31-1. The signal here is a composite of all four waveforms.

These same waveforms pass through level-set potentiometers R6, R10, R86, and R90 to summing resistors R32, R33, R31 and R47 at the inverting input of operational amplifier U31-7. The output of this amplifier is a composite signal, all componenets of which are opposite in polarity to their counterparts in the composite signal developed at the input of operational amplifier U31-1 by the unattenuated sawtooth and parabolic waveforms.

The two composite signals are added together algebraically via summing resistor R39 at input pin 2 of operational amplifier U31-1 to produce a composite signal at the output with sawtooth and parabolic waveforms that are reversable in polarity and adjustable in amplitude with shading controls R6, R10, R86, and R90. From the output of U31-1 the resultant signal is used to drive Q31. Its output can be viewed at test point TP41.

Potentiometer R41 adds dc voltage to the base of Q31 to set the amount of amplitude modulation available. Transistor Q31 then serves as a driver for the shading modulator on the video board (A501).

11.2.4 Black Balance

The BLACK BAL control (R46) is a passive voltage divider. This dc level establishes a video level near black level below which shading modulation is not possible.

11.3 DEFLECTION BOARD (A503)

Circuits on the deflection board generate six repetitive waveforms and two dc control signals described in table 11-3. The waveforms generated are:

Table 11-3. Inputs and Outputs, Deflection Board (A503)

INPUT POWER	+20 V dc (terminal 102) -10 V dc (terminal 117)
INPUT SIGNALS	
Sync In (terminal 16)	Negative-going 4 V p-p mixed sync.
OUTPUT SIGNALS	
Horizontal Size (terminal 10)	Adjustable dc voltage from approximately 0 to +20 V.
Horizontal Drive (terminal 11)	Positive-going 5 V p-p pulses occuring at horizontal-scan rate.
Horizontal Trigger (terminal 12)	Positive-going pulse about 10 V p-p occuring at horizontal-scan rate.
Vertical Trigger (terminal 14)	Positive-going 10 V p-p pulse occuring about every 16.75 ms. Pulse width approximately 640 μs.
Clamp (terminal 13)	Positive-going 10 V p-p pulse occuring at the horizontal-scan rate. Pulse width approximately 1.5 μs.
Horizontal Center (terminal 4)	Adjustable dc voltage.
Vertical High (terminal 3)	10 V p-p sawtooth waveform with a positive ramp. Repetition rate 16.75 ms.
Vertical Low (terminal 8)	5 V p-p sawtooth waveform with a positive ramp. Repetition rate 16.75 ms.

- horizontal-trigger pulses
- vertical-trigger pulses
- vertical-rate deflection waveforms (vertical high and vertical low)
- clamp pulses
- horizontal-drive pulses

The two dc voltages control horizontal size and centering.

Negative-going sync pulses are inverted by Q1 to drive the waveform generating circuits (figure 11-4). The vertical-sync generator circuit (U11-13) is a multivibrator that uses the inverted sync pulses to drive its two outputs, Q and not-Q. The pulses on the Q output are positive-going. They trigger the vertical generator located on the shading board (A502). The negative-going pulses from the not-Q output drive the vertical-deflection circuit. This circuit produces two sawtooth waveforms, vertical high and vertical low, with centering and amplitude controlled by R67 and R70. These sawtooth waveforms drive the vertical-deflection coil winding portion of L1 in the Camera. The inverted sync pulses from Q1 also drive multivibrator U11-5, whose

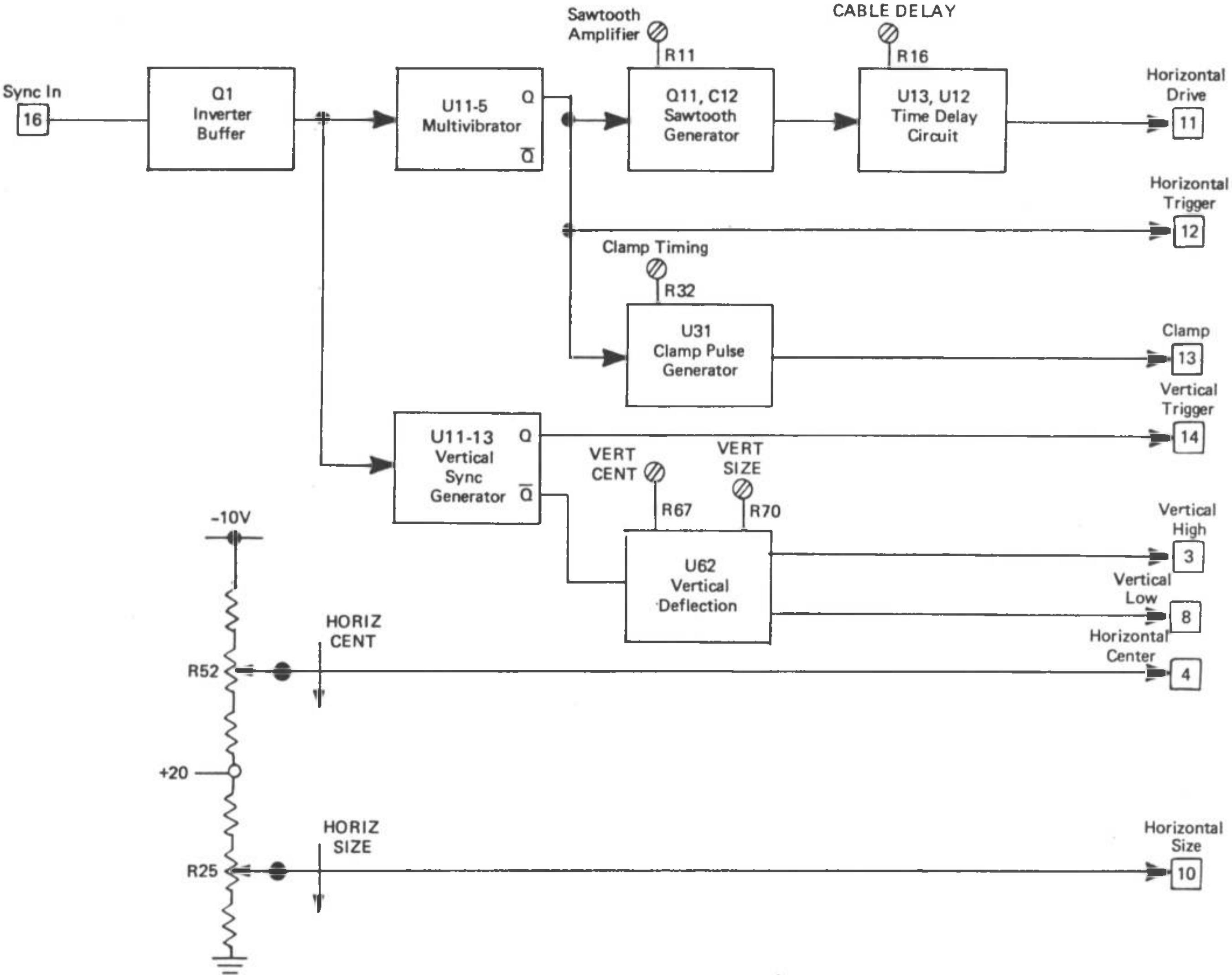


Figure 11-4. Functional Diagram, Deflection Board (A503)

positive-going Q-output pulse drives the cable delay circuit. The cable delay compensates for delay time of the various video signals frequencies due to cable length. In this circuit a positive-ramp sawtooth waveform is produced having peak-to-peak amplitude determined by potentiometer R11. When the sawtooth rises to a level equal to the voltage set by cable delay control R16, comparator U13 supplies a negative pulse to timer U12. The positive-going output pulse of this timer turns on Q12 to clamp the horizontal drive (terminal 11) line to ground through R22. This output drives the horizontal-deflection circuit in the Camera.

The clamp-pulse generator produces a positive-going pulse to drive the horizontal generator on the shading board (A502). The horizontal-size (HORIZ SIZE) circuit is a passive voltage divider. Selected amounts of dc voltage controls amplitude of the sawtooth waveform generated by a horizontal-deflection circuit located on the deflection board (A3) in the Camera.

The horizontal-center (HORIZ CENT) circuit is another passive voltage divider. Selected amounts of dc voltage output controls gain of the skew control amplifier located on the deflection board (A3) in the Camera.

11.3.1 Horizontal Sync Pulse Generator (Figure 14-4, Sheet 1)

A TTL-level negative-going composite sync signal received at board terminal 16 is reversed in polarity by transistor Q1. The positive transition of this pulse triggers multivibrator U11-5. When triggered, the multivibrator provides a positive pulse at U11-5, which is coupled to board terminal 12, where it serves as the horizontal-trigger output pulse. Width of the output pulse is determined by an RC circuit formed with R11, R12, and C11. Potentiometer R11 is adjusted so that the duration of these pulses will be about 70 percent of the horizontal-line time for all scan rates, which prevents the multivibrator from being triggered during the vertical interval, except with every other pulse or vertical serration.

11.3.2 Vertical Sync Pulse Generator

This circuit operates in much the same way as the horizontal sync pulse generator, described in section 11.3.1. The positive pulse from the collector of Q1 triggers multivibrator U11-13. The positive output pulse at U11-13 is coupled to board terminal 14, where it serves as the vertical-trigger output pulse. Pulse width is determined by an RC circuit composed of C42 and R42.

11.3.3 Cable Delay and Horizontal-Drive Pulse

The positive-going pulse from multivibrator U11-5, (section 11.3.1) forward biases Q11, which discharges C12. When the pulse ends, Q11 turns off and C12 charges via R14 toward +12 V. The resulting waveform across C12 is a sawtooth with a positive ramp having a peak-to-peak amplitude determined by R11. The sawtooth waveform drives comparator U13-7 at the inverting input. When the positive ramp of the sawtooth rises to a level equal to that set with CABLE DELAY control R16, U13 supplies a negative-going pulse at U13-7. The negative-going transition of this pulse triggers timer U12. The output at pin 3 is a positive-going pulse. Pulse width is determined by an RC circuit composed of C17 and R23. Transistor Q12 couples this pulse to board terminal 11, where it serves as the horizontal-drive output pulse.

11.3.4 Clamp-Pulse Generator

The output pulse from U11-5 (section 11.3.1) drives multivibrator U31-5. Width of the positive output pulse, at terminal U31-5, is set to about 3 microseconds with the Clamp Timing circuit made up of C31, R31, and potentiometer R32. The positive transistion of the pulse from U31-5 triggers multivibrator U31-13. The output pulse on pin 13, a 1.5 microsecond negative clamp pulse, is delayed approximately 3 microseconds with reference to the leading edge of horizontal sync. This is applied to terminal 13.

11.3.5 Vertical-Deflection Waveform Generator (Figure 14-4, Sheet 2)

Capacitor C61 charges in a negative direction from current through R63 also being applied to the inverting input of U61-2. A negative-going pulse from U11-4 (sheet 1) is applied to the base of Q61, turning it on to rapidly discharging C61. This repeated action produces a sawtooth waveform with a negative ramp at U61-6. This waveform is applied to U62-1, which is a summing point for the sawtooth, centering voltage, and yoke feedback voltage.

Vertical-centering voltage is adjusted by R67 and coupled through R68 to summing point U62-1.

The last summing-point voltage is developed across R71 as a feedback signal from the low end of the vertical yoke in the Camera. This current makes the amplifier operates as a constant-current generator, thus preventing variations in copper coil resistance from adversely affecting vertical-deflection performance. Potentiometer R70 establishes vertical size. These three voltages provide for linear ramp current through the vertical winding of the yoke in the Camera.

11.3.6 Horizontal-Size Control

The horizontal-size control (sheet 1) is a passive voltage divider composed of R24, R25, and R26. Potentiometer R25 allows selection of the desired dc voltage used at the Camera to control the amplitude of the sawtooth current waveform in the horizontal-deflection coil winding.

11.3.7 Horizontal-Center Control

The horizontal-center control (sheet 2) is a passive divider composed of R51, R52, and R53. Potentiometer R52 allows for selection of the desired dc voltage. This voltage is applied to terminal 4. It is routed to the skew control circuit in the Camera (section 4.2.5).

11.3.8 +12 Volt Regulator

Voltage regulator U80 (sheet 1) converts the +20 volt regulated dc input signal to +12 volts for use with most of the circuits on the deflection board.

11.4 SYNC GENERATOR BOARD (A504-1)

The sync generator board produces three repetitive waveforms. They are described in table 11-4.

Table 11-4. Inputs and Outputs, Sync Generator Board (A504-1)

INPUT POWER	+5 V dc (terminal 15) -10 V dc (terminal 17)
INPUT SIGNALS	
(terminal 112)	50 or 60 Hz (power line frequency)
OUTPUT SIGNALS	
Vertical Drive (terminal 110)	Not Used
Mixed Blanking (terminal 3)	Negative-going pulse, fixed at a nominal amplitude of 4 V p-p from 75-ohm sources.
Horizontal Drive (terminal 108)	Positive-going 5 V p-p pulses, occuring at horizontal-scan rate.
Mixed Sync (terminal 16)	Negative-going pulses fixed at a nominal amplitude of 4 V p-p from 75-ohm sources.

For descriptive purposes the sync generator circuits can be broken down into the sections indicated in figure 11-5. The heart of the sync generator in a master oscillator that generates a rectangular waveform (clock pulses) with a repetition rate of 19.845 MHz. By the process of binary countdown, repetition rate of this oscillator waveform is progressively reduced by two 2-bit variable-modulus counters, an 8-bit variable-modulus counter and an 11-bit variable-modulus counter to provide a variety of start and stop pulses at line and field rates and also at multiples and submultiples of the line rate. These start and stop pulses, then, are shaped into the specified output waveforms by logic circuits formed by combinations of gates, inverters, and multivibrators.

Master-oscillator circuits can operate under control of an internal crystal oscillator or, by jumper selection, locked to line frequency. Pulses generated by the master oscillator drive a 2-bit variable-modulus counter. By switch selection it can operate in a divide-by-2 or a divide-by-3 mode. Operation mode for the 2-bit variable-modulus counter depends on scan rate. Output of the 2-bit variable-modulus counter clocks the 8-bit variable-modulus counter, which can be made to count any desired number of input pulses up to its limit of 256 before it resets. Output frequency of the counter is double horizontal frequency, or 2H, as determined by the switch positions of switch bank S21.

Output pulses from the 8-bit variable-modulus counter are supplied for the processor and the interlace divider. The processor consists of a programmable read-only memory (PROM), a 2-line-to-1-line data selec-

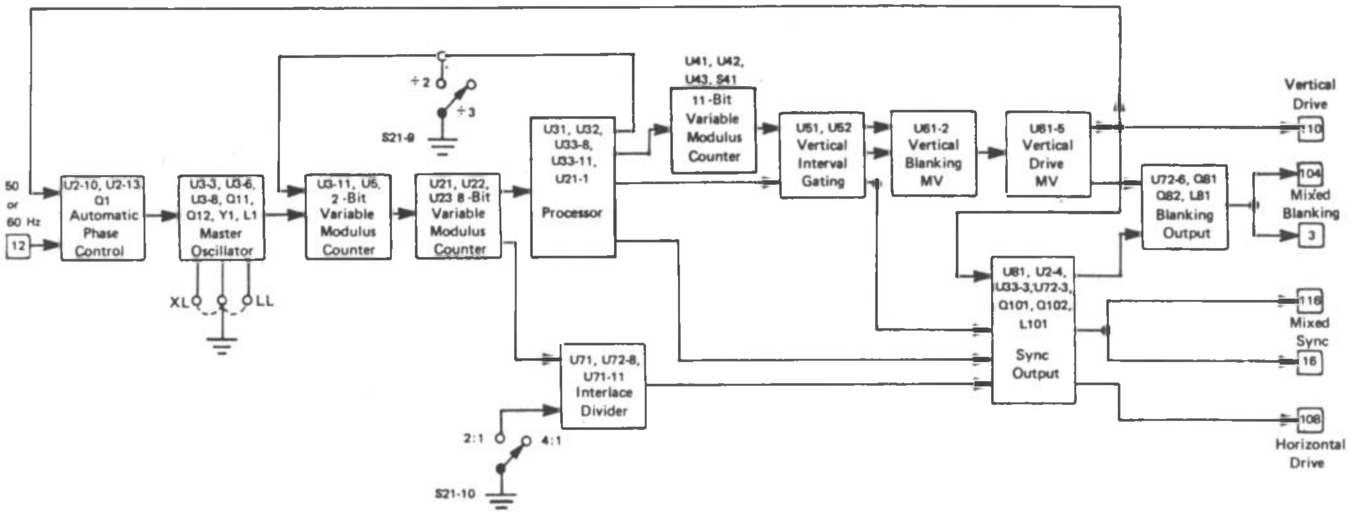

50
or
60 Hz
12
U2-10, U2-13, Q1 Automatic Phase Control
U3-3, U3-6, U3-8, Q11, Q12, Y1, L1 Master Oscillator
XL
LL
U3-11, U5, 2-Bit Variable Modulus Counter
÷2
÷3
S21-9
U21, U22, U23 8-Bit Variable Modulus Counter
U31, U32, U33-8, U33-11, U21-1 Processor
U41, U42, U43, S41
11-Bit Variable Modulus Counter
U51, U52 Vertical Interval Gating
U61-2 Vertical Blanking MV
U61-5 Vertical Drive MV
U72-6, Q81 Q82, L81 Blanking Output
U81, U2-4, U33-3, U72-3, Q101, Q102, L101 Sync Output
U71, U72-8, U71-11 Interlace Divider
2:1
4:1
S21-10
Vertical Drive
10
104
Mixed Blanking
3
116
Mixed Sync
16
108
Horizontal Drive

Figure 11-5. Functional Diagram, Sync Generator Board (A504)

tor, and NAND gates. The PROM is programmed to generate two groups of these pulses in proper time sequence: vertical-sync serrations, horizontal sync, equalizing pulses, and horizontal-blanking pulses. One group of pulses is for 525 to 625 line rates, the other group is for 627 to 1225 line rates. Pulse durations versus scan rates are shown in table 11-5.

Table 11-5. Pulse Duration Verses Scan Rate

LINE RATE	HORIZ SYNC	VERTICAL SERRATIONS	EQUALIZING	HORIZ BLANKING	FRONT PORCH	HORIZ DRIVE
525 – 625	4.83 ±0.2 μs	4.5 ±0.2 μs	2.46 ±0.2 μs	10.87 ±0.5 μs	1.81 ±0.2 μs	6.6 ±0.2 μs
627 – 1225	2.82 ±0.25 μs	2.01 ±0.25 μs	1.2 ±0.1 μs	6.85 ±0.2 μs	0.8 ±0.1 μs	3.62 ±0.25 μs

The interlace divider divides frequency of the input signal from the 8-bit variable-modulus counter by 2 or 4, depending on the position of S21-10, to produce the desired scan-line interlace pattern.

The 11-bit variable-modulus counter reduces input frequency to a vertical rate of 50 or 60 Hz. The output triggers the vertical-interval gating circuit, which in turn produces pulse waveforms used to generate the vertical-drive pulse, vertical-blanking intervals, and composite sync waveforms. Waveforms from the interlace divider, vertical blanking, vertical drive, and the processor are combined in the sync output circuit to produce a composite sync signal. Horizontal-drive pulses are also produced in this output stage. Vertical-blanking signals are combined with horizontal-blanking signals to produce a composite blanking signal called mixed blanking.

11.4.1 Master Oscillator (Figure 14-5, sheet 1)

The master oscillator operates under control of its internal crystal oscillator (Y1) when the jumper is in XL position or locked to line frequency when the jumper is in the LL position.

When the sync generator is operating in the crystal mode, the line-lock Colpitts oscillator is disabled by grounding the base of Q11 with a plug-in jumper (XL).

The crystal oscillator is formed by interconnecting two integrated-circuit NAND gates (U3-3, U3-6) with crystal Y1. Oscillation is sustained by positive feedback from U3-3 through Y1 to U3-4. NAND gate U3-8 is enabled in the crystal-control mode with a positive voltage at U3-10. A negative-going clock-pulse edge produced at U3-8 (TP2) triggers the 2-bit counter.

When the sync generator is operating in the line-lock mode, the crystal-controlled multivibrator oscillator is disabled by grounding terminal U3-1 with a plug-in jumper (LL). Moving the jumper (from XL) to this position also activates transistor Q11, which operates as a Colpitts oscillator tuned with L1. Output of the Colpitts oscillator, at the Q11 emitter, is a sinusoidal waveform with a repetition rate of 19.845 MHz.

Frequency is maintained with varactor CR1, a variable capacitance diode controlled by a dc voltage. During line-lock operation, this dc control voltage is derived from the automatic phase-control section.

Transistor Q12 acts as a buffered switch to convert the Colpitts oscillator output waveform to a rectangular waveform at U3-10. NAND gate U3-8 (TP2) provides a negative-going rectangular waveform which triggers the 2-bit variable-modulus counter.

11.4.2 Automatic Phase Control

When the sync generator is operating in the line-lock mode, Q11 in the master-oscillator stage is locked to the ac line power by a circuit formed with unijunction transistor Q1, NOR gates U2-10 and U2-13, and varactor diode CR1. Reference frequency for this circuit is a 6.3-volt, 50- or 60-Hz sinusoidal waveform appearing at board terminal 112. The divided down 19.845 MHz from Q11 is applied to U2-8 as a 50- or 60-Hz signal for comparison with the 50- or 60-Hz line power frequency. Each positive alternation of the sine wave triggers Q1 to generate a fast-rise positive spike. These pulses and the divided down 19.845-MHz waveform (50 or 60 Hz vertical drive output signal) alternately set and reset the flip-flop formed by gates U2-10 and U2-13. The resultant output of the flip-flop is a waveform with a duty cycle that varies with phase difference between the two triggering signals. Normally the waveform has a 50% duty cycle. In the low-pass filter (R3, R4, C3, C4), a dc control voltage is developed proportional to the average value of the pulse waveform. This dc voltage applied to varactor CR3 establishes its capacitance. Introduced into the resonant circuit of the Colpitts oscillator, this capacitance keeps it at the desired frequency.

11.4.3 Two-Bit Variable Modulus Counter

This 2-bit binary counter consists of a dual J-K negative-edge-triggered flip-flop (U5) and NAND gate U3-11. With a high positive-logic level (1) at U3-12, supplied by an open S21-9, this 2-bit counter functions as a divide-by-3 (modulo 3) counter. With S21-9 closed a low logic level (0) at U3-12 causes it to function as a divide-by-2 counter. The mode of operation for this 2-bit counter depends on the required scan rates, as defined in table 11-5.

11.4.4 8-Bit Variable Modulus Counter

A binary counter of this type can be made to count any number of input pulses up to a limit fixed by the number of bits in the counter. The counter used in this sync generator will count any selected number of pulses from one to 256 before it resets.

The counter consists of two synchronous 4-bit counters (U21, U22) and an 8-input NAND gate (U23) connected together via switch bank S21. Output frequency of the counter is double the desired horizontal frequency, or 2H, as determined by the switch positions of switch bank S21. A buffered clock input (pin 2) triggers the counters on the rising (positive-going) edge of the clock input waveform. The counters are cascaded by the ripple-carry output (pin 15) of U22 being coupled to the count-enable inputs (pin 7, 10) of U21. When U22 reaches full count, its ripple-carry output (pin 15) goes high, which allows U21 to begin counting.

Switches 1 through 8 of switch bank S21 are used to select the count in this 8-bit variable-modulus counter. Also, switch S21-9 will determine input frequency to this counter, where S21-9 is open for line rates $\leqslant 625$ and closed for line rates > 625. When all eight switches are closed, the counter will have a maximum count of 256. At maximum count all inputs to NAND gate U23 are high, and its output (pin 8) goes low. This high-to-low transistion couples back to the clear inputs (pin 1) of the counters, and all the flip-flop outputs are set low after the next clock pulse. Thus the output of this variable-modulus counter (U23-8) provides one negative pulse for every 256 clock pulses when all the switches are closed.

For lower count periods some of the switches are opened; switch S21-1 is the least significant bit.

Six other outputs from the 8-bit variable-modulus counter are supplied to the processor, which is described in the following section.

11.4.5 Processor

The processor consists of U31, a programmable read-only memory (PROM); a 2-line-to-1-line data selector (U32); and NAND gates U33-8, U33-11, and U2-1 (sheet 2). The PROM is programmed to generate two groups of the following pulses in their proper time sequence:

- vertical-sync serrations
- horizontal sync
- equalizing pulses
- horizontal-blanking pulses

One group of pulses is for 525 to 625 line rates; the other group is for use with 627 to 1225 line rates. Switch S21-9 supplies an output to the 2-bit variable-modulus counter. When switch S21-9 is in the ÷ 3 position, for 525 to 625 line rates, data selector U32 allows input signals on pins 14, 11, 5, and 2 (vertical-sync serrations, horizontal sync, equalizing pulses, and horizontal-blanking pulses) to be gated through to the sync output section. Alternately, when switch S21-9 is in the ÷ 2 position, for 627 to 1225 line rates, the vertical-sync serrations, horizontal sync, equalizing pulses, and horizontal-blanking pulses will be selected.

Relationships of the data-selector output signals for the ÷ 3 mode are shown as waveform B, D, E, and F in the horizontal-timing diagram of figure 11-6. Waveform periods are measured in clock pulses, where the period of one clock pulse is 4/f', since the least-significant bit is taken from U22-12 in the 8-bit variable-modulus counter. The vertical-sync serrations are inverted (waveform C, figure 11-6) by NAND gate U33-8 before being passed on to the sync to generate the horizontal-drive pulse in the sync output section. NAND gate U33-11 simply inverts the horizontal-blanking signal.

A negative pulse (waveform A, figure 11-6) is applied to pin 15 of the data selector (U32), which enables it for the period during which the above pulses are being clocked.

11.4.6 11-Bit Variable-Modulus Counter (Figure 14-5, sheet 2)

This counter consists of three synchronous 4-bit up/down counter (U41–U43) and switch bank S41. Counters are connected in cascade and wired for the countdown mode of operation to reduce the 2H input frequency to a vertical rate of 50 or 60 Hz. Counters are cascaded in the countdown mode by coupling the borrow output pulse (pins 13), produced when one counter underflows, to the succeeding counter countdown input (pin 4). The borrow output of the last counter (U43-13) couples back to the load inputs (pin 11) of all the counters. When the final borrow output goes low, counters are loaded to agree with the data inputs of switch bank S41. Switch positions of switch bank S41 are set for the desired scan rates as described in section 12.5.3.

With all switches opened a maximum count of 2048 is required to produce one output pulse. For lower count periods some of the switches are closed. The number of scan lines is always an odd number, therefore the least significant bit (U41-15) is left open to always produce an odd count.

11.4.7 Vertical-Interval Gating

The vertical-interval gating circuit produces pulse waveforms that are used to generate the vertical-drive pulse, vertical-blanking interval, and composite sync waveforms. The circuit consists of a 4-bit

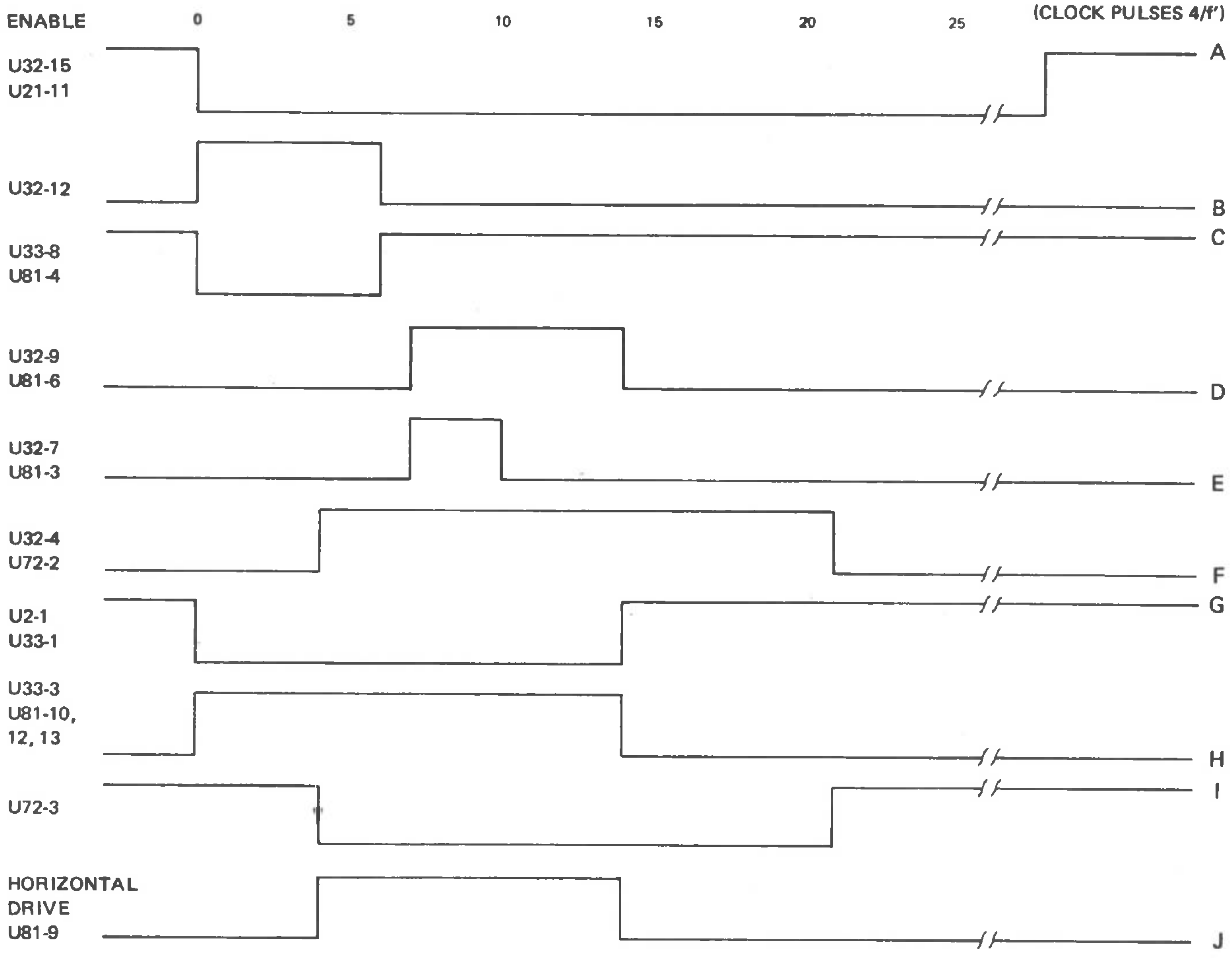


Figure 11-6. Horizontal-Timing Diagram

variable-modulus counter (U51) and a dual J-K negative-edge-triggered flip-flop with preset (U52). A 50/60 Hz jumper is used to set up U51 to divide by 5 for the 50 Hz position or divide by 6 for the 60 Hz jumper position.

Input frequency (U51-8), which comes from the processor, is twice horizontal-scan rate (two times the horizontal-blanking pulse rate). It is shown as waveform K in figure 11-7. Waveforms shown here are generated when the 50/60 Hz jumper is in the 60-Hz position. The timing cycle is initiated by a 60-Hz pulse (waveform L, figure 11-7) from the 11-bit variable-modulus counter. This negative pulse applied to U52-4 (preset) allows U52-9 and U51-13 (master reset) to go high. This high at the 4-bit variable modulus counter master reset terminal enables U51 to begin counting the input pulses. With U51 in divide-by-6 mode (60 Hz), its output at pin 12 (waveform N, figure 11-7) will change state after every six (five for 50 Hz) positive transitions of input signal. As a result waveform N has a period that is three horizontal lines long (2.5 lines for 50 Hz). When the output of U52 (waveform M, figure 11-7) goes low after four input counts, U51 is disabled at pin 13 and stops counting input pulses (waveform N stays low until the next 60-Hz pulse). Waveforms M and N supply inputs to the vertical-drive multivibrator circuit. Waveform N also supplies inputs for the vertical-blanking multivibrator and the sync output circuits.

11.4.8 Vertical-Blanking and Vertical-Drive Circuits

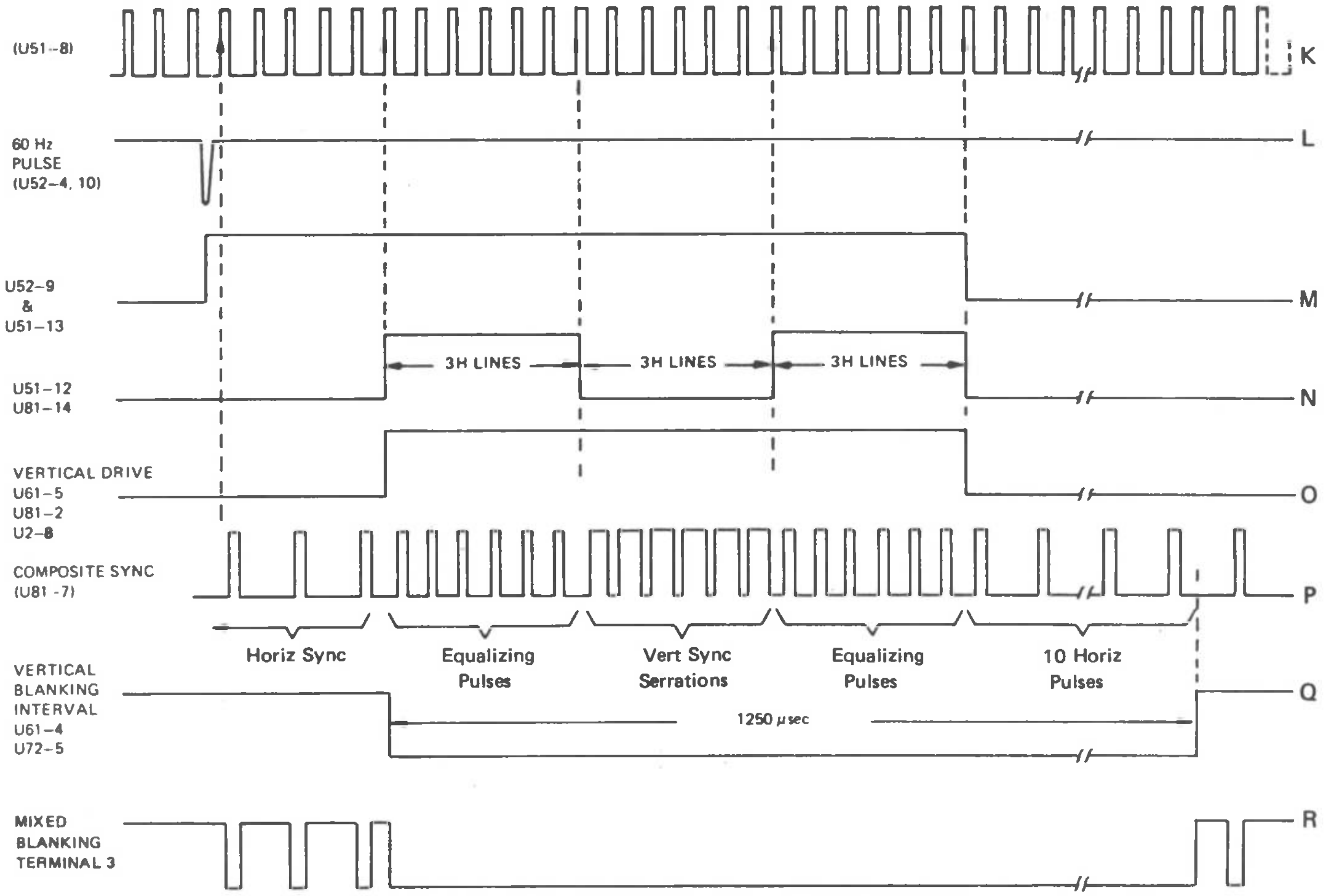


Figure 11-7. Vertical-Timing Diagram

The vertical-blanking and vertical-drive circuits basically consists of a vertical-blanking multivibrator and vertical-drive multivibrator, both of which are contained in the same package (U61). Circuits are triggered by positive-going pulses. Once fired, outputs are independent of further clock transistions and become a function of external RC timing components (Rext U61-7, Rext-15 and Cext U61-6, Cext-14) or the output pulse width can be terminated by the overriding clear (U61-11). Pulse width is defined by the relationship:

$$\text{Pulse width} \approx 0.7\ C_{ext}\ R_{ext}$$

The vertical-blanking multivibrator is triggered at pin 2 by the first positive transition of waveform N, figure 11-7. The output at U61-4 (waveform Q, figure 11-7) times out by R61 and C61 to produce a 1250 μs negative vertical-blanking pulse.

The vertical-drive multivibrator is also triggered by waveform N. Its output at U61-5 (waveform O, figure 11-7) is terminated at the clear input (pin 11) by the negative transistion of waveform M to produce a positive vertical-drive pulse. This vertical-drive is not used in 8000 Series Cameras and CCUs.

11.4.9 Interlace Divider

This circuit divides the frequency (2H) of the input signal from the 8-bit variable-modulus counter by 2 or 4 to produce the desired scan line interlace pattern. A dual J-K negative-edge-triggered flip-flop (U71) and NAND gates U72-8, U72-11 combine to divide by 2 when a low logic-level is applied to preset terminal U71-10. With a low on the preset terminal, U71-9 is high, which allows NAND gate U72-8 to be contolled by the signal at U72-10. Therefore, the output signal at U72-8 has a frequency of one-half the input (H) to produce a 2:1 interlace pattern. Coversely, with a high on U71-10, the circuit divides by 4 to produce a 4:1 interlace pattern. NAND gate U72-11 inverts the signal to provide the proper polarity for the sync circuits.

11.4.10 Sync Output

The sync output circuit gates the horizontal-blanking signal through to the blanking output circuit and combines vertical- and horizontal-sync signals to produce a composite sync signal. The circuit consists of dual 4-line-to-1-line data selector/multiplexer U81 and NAND gates U33-3, U2-4, and U72-3.

The horizontal-sync pulses, equalizing pulses, and vertical-serration pulses are combined at the proper times in U81 to produce a composite sync signal at U81-7. A low logic-level must be applied to the strobe input, U81-1, to enable the data selector to pass the selected pulses to the output at pin 7. NOR gate U2-4 combines the vertical-drive pulse (waveform O, figure 11-7) and the output of the interlace divider (waveform R, figure 11-7) to enable the data selector at the proper horizontal intervals. The signals applied to pins 2 (waveform O, figure 11-7) and 14 (waveform N, figure 11-7) of U81 determine which input pulses (vertical sync serrations, horizontal sync or equalizing pulses) will be gated through and combined to produce the composite sync signal shown as waveform P, figure 11-7. When both U81-14 and U81-2 are low, the horizontal-sync pulses are gated through; when both U81-14 and U81-2 are high, equalizing pulses are gated through and so forth. The composite sync signal is then amplified and shaped by a two-stage amplifier formed with transistors Q101 and Q102. A low-impedance composite-sync output signal designed to drive a 75-ohm load is available at terminal 16. The rise and fall times of this signal are established at about 100 ns with low-pass filter R107, C102, L101, R108.

Data selector U81-9 generates the horizontal-drive pulse. NAND gate U33-3 inverts waveform G (figure 11-6). This inverted signal (waveform H, figure 11-6) is applied as the data selector input U81 at pins 10, 12, and 13. The horizontal-blanking signal applied to pin 2 of NAND gate U72 has a frequency of twice the horizontal-scan rate, or 2H. This 2H signal is gated through the NAND gate at a horizontal-rate by the interlace divider signal, which is applied to U72-1. Output of NAND gate U72-3 (waveform I, figure 11-6) strobes data selector U81 at pin 15, which starts the beginning of the horizontal-drive pulse (waveform J, figure 11-6). The horizontal-drive pulse is terminated by the negative transition of waveform H, resulting in the desired horizontal-drive output pulse at terminal 108.

11.4.11 Blanking Output

Transistors Q81, Q82, and NAND gate U72-6 make up the blanking-output circuit. This circuit combines the vertical-blanking signal (waveform Q, figure 11-7) applied at pin 5 of NAND gate U72 with the horizontal-blanking signal applied at U72-4 to produce a composite blanking signal of proper shape and amplitude at board terminal 3. Rise and fall times of blanking pulses are established at about 100 ns with low-pass filter R87, R88, C82, L81.

11.5 BLANKING GENERATOR BOARD (A504-2)

The blanking generator output contains both horizontal- and vertical-blanking pulses (table 11-6) synced to the mixed-sync input signal. Figure 11-8 shows a functional diagram of the blanking generator board.

Horizontal-trigger pulses enter the board at terminal 12. The positive-going edge of these pulses drives the horizontal-advance generator circuit. This circuit gives control of blanking pulse positioning by adjustment of potentiometer R7. Pulses out of the horizontal-advance generator drive the horizontal-blanking generator. Two pulses are produced in this circuit, one positive and one negative. Both sets of pulses have the same pulse width as determined by the setting of potentiometer R21.

Negative-going horizontal-blanking pulses from the horizontal-blanking generator drive the X2 generator to produce negative-going pulses at twice the horizontal-blanking rate.

Vertical-trigger pulses enter the board on terminal 14. These pulses drive the vertical-advance generator,

Table 11-6. Inputs and Outputs, Blanking Generator Board (A504-2)

INPUT POWER	+5 V dc (terminal 115) +20 V dc (terminal 102) -10 V dc (terminal 117)
INPUT SIGNALS	
Horizontal In (terminal 12)	Positive-going 10 V p-p pulse. Repetition rate varies with horizontal-line rate.
Vertical In (terminal 14)	Positive-going 10 V p-p pulse occuring about every 16.75 ms. Pulse width approximately 640 μs.
OUTPUT SIGNALS	
Blanking Out (terminal 3)	Composite of vertical-and horizontal-blanking pulses. Nominal amplitude 4 V p-p.

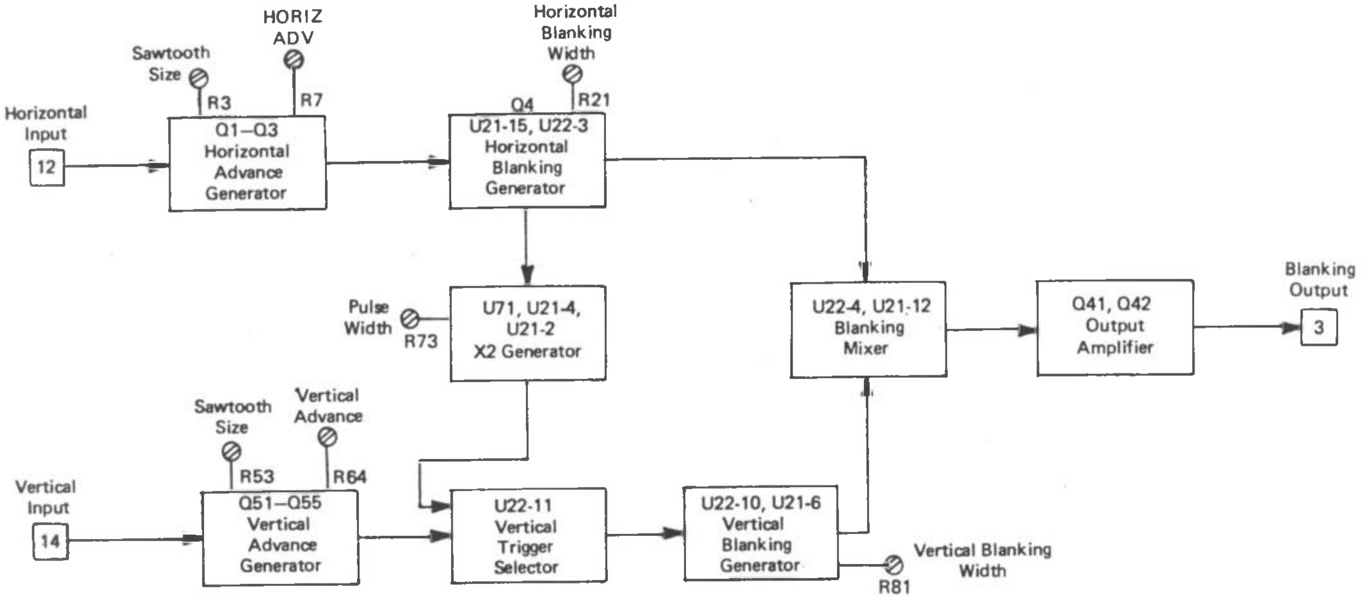

Horizontal Input
12
Sawtooth Size
R3
HORIZ ADV
R7
Q1–Q3 Horizontal Advance Generator
Horizontal Blanking Width
Q4
R21
U21-15, U22-3 Horizontal Blanking Generator
Pulse Width
R73
U71, U21-4, U21-2 X2 Generator
U22-4, U21-12 Blanking Mixer
Q41, Q42 Output Amplifier
Blanking Output
3
Vertical Input
14
Sawtooth Size
R53
Vertical Advance
R64
Q51–Q55 Vertical Advance Generator
U22-11 Vertical Trigger Selector
U22-10, U21-6 Vertical Blanking Generator
R81
Vertical Blanking Width

Figure 11-8. Functional Diagram, Blanking Generator Board (A504-2)

which operates in a similar manner to the horizontal-advance generator. Positioning of vertical-blanking pulses is achieved by adjusting R64.

The vertical-trigger selector is driven by negative-going pulses from the X2 generator and pulses from the vertical-advance generator at the vertical rate. A coincidence of these two signals causes a train of positive-going pulses to apperar at the output of the trigger selector. They drive a monostable multivibrator. This produces the vertical-blanking pulse. Pulse width is set with R81. Positive-going horizontal-blanking pulses and positive-going vertical-blanking pulses are applied to the input of the blanking mixer. Output pulses are a positive-going composite of horizontal- and vertical-blanking pulses. Pulses are amplified at the output and impedance matched for a 75-ohm line.

11.5.1 Horizontal-Advance Generator

Horizontal-advance circuits (figure 14-6) give control of the positioning of blanking pulses over a range of about 0.85 to 1.6 microseconds. Input to this circuit at terminal 12 of the board is a pulse that ranges from zero to +4 volts. Its duration and repetition rate vary with horizontal-line rate. For a 525-line rate, this pulse is positive for about 55 μs and at zero volts for about 10 μs. The actual timing of this pulse is consistent with the 63.5 μs required for 525-line scanning.

Transistor Q1 is a constant-current source that charges C2. The voltage developed across C2 places an equivalent charge on C1–less the 0.6 volts drop across the base-emitter junction of transistor Q3.

When the pulse into terminal 12 of the circuit board goes positive, transistor Q2 goes into saturation and pulls the juction of C1-C2 to ground. Potentiometer R3 is set so voltage on C2 at the instant prior to discharge is 5.5 volts. Capacitor C2 is discharged to ground.

But C1 is not. At the instant just prior to the transistor pulling C1-C2 to ground, this capacitor has 5.5 volts on its left lead and 0.6 volts on its right lead. The right lead is 4.9 volts less positive than the left lead. When this left lead is pulled to ground by Q2 (within a few tenths of a volt), the right lead is still 4.9 volts less positive than the left lead. Since the left lead is effectively tied to ground, the right lead is at about -4.9 volts.

Connected to this right lead is the base of transistor Q3. It had been conducting, but the -4.9 volts turns it off. The base-emitter junction is reversed biased.

Current through R9 immediately begins discharging this negative voltage, pulling the base voltage back toward +0.6 volt, and saturation. The rate with which this discharging takes place depends on the setting of potentiometer R7. The more positive (clockwise) it is set, the more quickly base voltage is pulled back toward 0.6 volt.

But it is not solely this discharging action through R9 that determines how soon Q3 reaches saturation. When Q2 release its collector from ground, constant-current source Q1 again begins charging C2. As voltage builds on C2, it pulls C1 along with it. The right lead of C1 increases voltage at the charge rate of C2. This voltage adds to the voltage already being applied by R9.

The base of Q3 reaches saturation due to the influence of both these voltages. But it is the adjustable charge rate provided by potentiometer R7 acting through R9 that determines horizontal-advance timing. The greater the current provided by this path, the more rapidly Q3 saturates to establish horizontal-advance timing.

11.5.2 Horizontal-Blanking Generator

Both inputs of NOR gate U22-3 are in a low state when the positive-going pulse from Q4 is applied to pin 1. The output of this NOR gate is forced low. This pulls the input of inverter U21-15 to a low state. Its output is forced high. This high remains on pin 2 of U22-3 after the high from Q4 returns to a low state. Thus, the output of the NOR gate is maintained low. It remains low until capacitor C21 charges sufficiently to place a high state on the input of the inverter.

This timing is determined by the setting of potentiometer R21, the horizontal-blanking width control. When the high state is reached, inverter output is forced to a low state. Since the high from Q4 had previously gone away, removal of the high state from the inverter forces the NOR gate output high.

This output had been high from the time of the positive-going leading edge from Q4 until time-out of the inverter circuit.

11.5.3 Vertical-Advance Generator

The positive-going rectangular-shaped 50- or 60-Hz vertical-trigger input pulse (field rate) drives the base of Q52 through current-limiting resistor R52. At pulse times, Q52 conducts and discharges capacitor C51 toward ground. Between pulses, Q52 is cut off, and C51 charges linearly through Q51 toward +16.2 volts. Due to this charging and discharging action, the waveform across the capacitor is a sawtooth with a fast-falling negative slope and a linearly rising positive slope, the peak-to-peak amplitude of which is set at 5.5±0.5 volts with R53. This sawtooth waveform drives Q53, a combination clamp and switch.

Base-to-emitter conduction at Q53 clamps positive peaks of the sawtooth to about 0.6 volt. The sawtooth starts rising to this voltage from a level established by the collector of Q54 in accordance with the setting of R64. While the clamping action is taking place, emitter-to-collector conduction in Q53 (which is saturated) causes the collector to switch from a positive level toward ground. The waveform that results at the collector is a negative-going rectangular pulse whose repetition rate is the field rate of 50 or 60 Hz. This pulse is amplified by transistor Q55, which also reverses its polarity. The pulse is restored to the original negative-going polarity by inverter U21-10.

11.5.4 X2 Generator

At the input, NOR gate U71-11 is driven at pin 12 with a negative-going horizontal-blanking pulse whose repetition rate is the same as horizontal-line rate.

When this negative pulse appears, the gate supplies a positive pulse at pin 11. The latter pulse drives pin 1 of NOR gate U71-3, thereby producing a negative pulse at U71-3. It also triggers a monostable multivibrator formed with NOR gate U71-10 and inverter U21-4. When triggered, the multivibrator supplies at U21-4 a positive pulse whose width is set with R73. This positive pulse drives pin 5 of NOR gate U71-4. It is also converted into a negative pulse by inverter U21-2 and applied to pin 6 of NOR gate U71-4. When the positive pulse at U71-5 ends, the long discharge time of C72 prevents a corresponding change from immediately taking place in the pulse at U71-4 and U71-2.

For an instant of time, therefore, both U71-5 and U71-6 are at approximately ground potential, which causes a positive pulse to appear at U71-4. The leading edge of this positive pulse at U71-4 is set with R73 so it is halfway between occurrences of the positive-going pulse edge at U71-1. As a result of these two pulses at U71-1 and U71-2, a negative pulse edge is supplied at U71-3 at a rate twice that of the horizontal-blanking pulse at U71-12.

11.5.5 Vertical-Trigger Selector and Vertical-Blanking Generator

The vertical-trigger selector is a NOR gate (U22-11); the vertical-blanking generator is a monostable multivibrator formed with NOR gate U22-10 and inverter U21-6. At U22-13, negative-going pulse edges are applied at twice the horizontal-blanking pulse rate while negative-going pulses with a repetition at field rate (50 or 60 Hz) are applied at U22-12.

When the vertical-blanking period starts, a coincidence of these two signals causes the gate to supply at U22-11 a train of positive pulses. The first pulse to appear triggers the multivibrator (U22-9). The multivibrator then supplies at U21-6 a positive-going pulse. This is the vertical-blanking pulse. Potentiometer R81 sets its width at 1333 μs for a 525-line system or 1250 μs in systems with higher line rates.

11.5.6 Blanking Mixer

The positive-going horizontal-blanking pulse is applied to U22-5 while the positive-going vertical blanking pulse is applied to U22-6. The appearance of either pulse causes a corresponding pulse of the opposite polarity to appear at U22-4. Whichever pulse appears at U22-4 is reversed in polarity by inverter U21-12 to provide a positive-going pulse at the output of the circuit.

11.5.7 Blanking Output Amplifier

The blanking output amplifier is a two-stage direct-coupled pulse amplifier composed of transistors Q41 and Q42. The first stage (Q41) operates as a switch. It is driven via resistor R32 with the mixed-blanking signal from the output of the blanking mixer circuit. The second stage (Q42) operates as a current amplifier. It matches high impedance of the Q41 collector circuit to the low impedance of the 75-ohm output line.

11.6 POWER SUPPLY ASSEMBLY (A506)

Most of the dc supply voltages required to operate the Camera and CCU are developed by circuits located in this assembly. The supply voltages produced include regulated potentials of +20 volts, -10 volts, +5 volts, +300 volts, and an adjustable zero to -100 volts. Input and output voltages and waveforms are further described in table 11-7. Figure 11-9 shows a functional diagram of the power supply board.

Table 11-7. Inputs and Outputs, Power Supply Board (A506-A1)

INPUT POWER	115 V ac or 230 V ac, 50/60 Hz.
INPUT SIGNALS	
White Level (terminal 3)	White peak level of video signal from the video board (A501).
Protect (terminal 10)	Bias voltage for PORTECT LED from deflection board (A3) in the Camera.
OUTPUT SIGNALS	
Filament High (terminal 14)	Unregulated +19 V dc.
Target Voltage (terminal 13)	Adjustable 0 to +20 V dc.
(terminal 15)	Unregulated +28 V dc for Camera circuits.
FOCUS (terminal 11)	Adjustable 0 to +20 V dc for Camera deflection board (A3).
(terminal 2)	Regulated +20 V dc.
(terminal 6)	Regulated +5 V dc.
(terminal 7)	Regulated -10 V dc.
(terminal 9)	Regulated +300 V dc.
(terminal 5)	6.3 V ac reference.
Beam (terminal 12)	Adjustable 0 to -100 V dc.

Power for the regulators is derived from four secondary windings on a step-down power transformer (T1) that is mounted on the power supply chassis. The ac power is rectified and filtered. Voltage regulators U1, U3, and U4 provide the -10, +20, and +5 V dc respectively. The +300 and -100 V dc are regulated by a voltage divider network.

The focus control circuit is a passive voltage divider. Selected amounts of dc voltage (from zero to +20 volts) control gain of the high-voltage supply, located on the deflection board (A3) in the Camera.

The TARGET AUTO/MAN switch (S2) allows the operator to choose between automatic or manual gain control of the target voltage. In the AUTO position gain of the target voltage is automatically controlled in the auto-target circuit. In the MAN position, gain of the target voltage is controlled by potentiometer R61, which is adjusted as needed for scene lighting conditions.

The adjustable zero to -100 volt supply controls beam current. It is derived from the +300-volt regulator through a voltage divider network. Voltage output is controlled by R30.

Located on the front panel of the power supply assembly is the POWER ON/OFF switch (S1), the POWER and the PROTECT indicator LEDs. The LED circuits are described in section 11.6.8 and 11.6.9.

11.6.1 +20 Volt Regulated Supply

Ac power from a 23-volt secondary winding on power transformer T1 (figure 14-7) is converted to a smooth dc voltage with a diode bridge rectifier (CR1) and a filter capacitor (C1). The dc voltage is regulated by U3, an adjustable voltage regulator. Resistors R38, R39, and variable resistor R40 set the output to +20 volts dc.

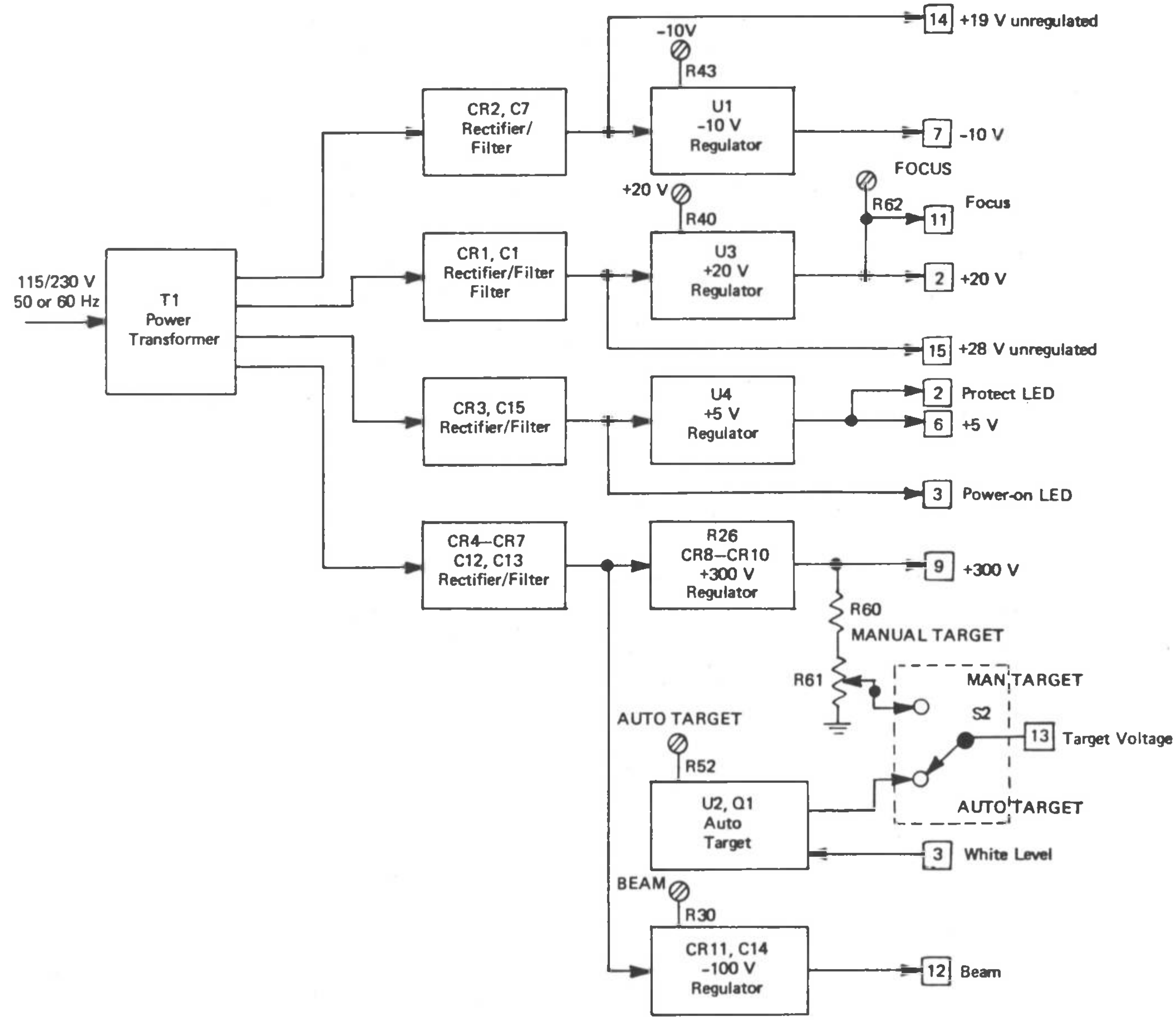


Figure 11-9. Functional Diagram, Power Supply (A506)

11.6.2 -10 Volt Regulated Supply

Ac power from a 19-volt secondary winding on the power transformer (T1) is converted to a smooth dc voltage with a diode bridge rectifier (CR2) and filter capacitor (C7). The dc voltage is regulated by an adjustable negative voltage regulator (U1). Resistors R41, R42, and variable resistor R43 set the output to the desired -10 volts dc.

11.6.3 +5 Volt Regulated Supply

Diode bridge rectifier (CR3) converts ac power from a 9-volt secondary winding on the power transformer (T1) to a smooth dc voltage filtered by C15. Voltage regulator U4 converts this rectified dc voltage to +5 V dc.

11.6.4 +300 Volt and -100 Volt Supply

The ac power for these two supplies comes from the 409-volt secondary winding on power transformer T1. In a diode bridge rectifier formed with CR4, CR5, CR6, and CR7, the ac voltage is converted into a dc potential of about 600 volts across filter capacitors C12 and C13. A 200-volt drop across R26 reduces this potential to 400 volts at the junction of R26 and CR8, with reference to the negative end of C13. The 400 volts is regulated by zener diodes CR8, CR9, and CR10. By grounding the junction of CR10 and CR11, regulated potentials of +300 and -100 volts are obtained with reference to this ground. A voltage divider (R30) is also placed between the regulated -100 volt line and ground to provide a stable voltage that is adjustable between 0 and -100 volts with R30, the BEAM control. Voltage at the arm of R30 is used on grid 1 of the image tube in the Camera to control the density of the electron beam.

11.6.6 Unregulated Voltages

The power supply develops two unregulated voltages. Bridge rectifier CR2 develops the +18 V dc used at the filament voltage regulator located in the Camera. Bridge rectifier CR1 produces the +28 V dc used in the focusing coil assembly located in the Camera.

11.6.7 Target Control

The TARGET AUTO/MAN switch (S2), located on the front panel of the power supply, allows the operator to choose between automatic or manual control of target voltage.

With switch S2 in the MAN position, target voltage is controlled by a passive voltage divider network composed of R60 and potentiometer R61.

When operating in the AUTO TARGET mode, target voltage is controlled automatically as scene illumination varies. The AUTO TARGET control (R52) and Auto White from the video board (section 11.1.12) received at board terminal 3 control gain of the amplifier circuit formed by operational amplifier U2 and transistor Q1. A filter network formed by C21, C22, and R55 block high-frequency noise.

11.6.8 Power on LED

The POWER ON LED (CR14), located on the front panel of the power supply, receives its operating voltage via bridge rectifier CR3 and current limiting resistor R45, which biases on the LED when power is applied to the CCU.

11.6.9 Protect LED

The circuit for the PROTECT LED (CR13) is located on the Camera deflection board (A3). This is described in section 4.2.4. When a horizontal- or vertical-deflection failure occurs the circuit biases on the LED through current limiting resistor R31.

11.6.10 Focus

Focus control R62 is a passive voltage divider. It allows selected levels from zero to 20 V dc to control gain of the high-voltage circuit, located on the deflection board (A3) in the Camera.

SECTION XII
MAINTENANCE

This section of the manual is intended for use only by technically qualified service personnel. These internal alignment and troubleshooting procedures are provided to maintain a CCU at optimum performance. Only technicians familiar with television camera maintenance should attempt these procedures. The customer service department of Cohu, Inc., Electronics Division, should be contacted if it is felt that assistance is needed in maintaining the CCU.

12.1 TEST EQUIPMENT REQUIRED

Table 12-1 lists the equipment needed for testing and adjusting the CCU. The required characteristics given are not necessarily those of the equipment recommended. They reflect the capabilities necessary to measure voltage, resistance, and other characteristics of the circuits to the required accuracy.

Table 12-1. Recommended Test Equipment

EQUIPMENT REQUIRED	REQUIRED CHARACTERISTICS	RECOMMENDED EQUIPMENT
Oscilloscope	50-MHz Bandwidth Dual trace	Tektronix Model 455
Sweep-Frequency Generator	50 or 75 Ω output 0.1 to 32 MHz Flat within ±0.5 dB	Hewlett-Packard Model 8601A
Voltmeter	0 to 30 V dc 105 to 260 V ac ±2% accuracy	Hewlett Packard Model 3476 A/B
Spectrum Analyzer	1 kHz to 50 MHz	Hewlett Packard Model 8553 B
TV Monitor	High Resolution	Cohu DM Series
Vidicon Simulator	Must match 50 or 75-ohm signal generator output to the high impedance of an image tube target circuit.	Cohu Model VS-2
Camera Test Jig	Must support Camera in a fixed position and provide backlighted 1600-line resolution chart and tv linearity chart	Cohu Model CTJ-2
Waveform Monitor	0.7 V and 2.0 V video signal adjustable to 1.0 V equivalent display height	Tektronix Model 1480

The recommended equipment models are listed because of their extensive use (and resulting wide familiarity) in the industry. Similar equipment can be substituted for these items by those familiar with test equipment capabilities and limitations. The resolution and linearity chart at the rear of this manual can be substituted for the test jig; however, information on these charts, especially 1600-line resolution, may not be entirely accurate due to possible paper shrinkage and printing limitations.

12.2 CLEANING AND LUBRICATION

Interior circuit areas of the CCU should be cleaned periodically to remove accumulated dust and film. For cleaning use a low pressure stream of air or a vacuum and a soft-bristle brush. Handle etched-circuit boards carefully, otherwise leads on components or etched-circuit paths could be broken.

The CCU does not require lubrication.

12.3 TROUBLESHOOTING

Become familiar with circuits in the CCU before attempting any troubleshooting. If a malfunction occurs, and the cause of the trouble is not immediately apparent, first try to isolate the malfunction to the circuit group where it is occurring. Generally, the best approach is to first check or correct dc supply voltages and waveforms on the plug-in circuit boards. Appropriate dc supply voltages are noted in the circuit description section and in the schematics in section 14. Troubleshooting procedures appear in table 12-2.

12.4 PERFORMANCE TESTING

The Camera and CCU should be periodically tested to determine correct performance. This functional checkout may be performed at any time, or at regularly scheduled intervals as determined by in-service use. To perform the functional checkout:

1. Perform the focusing adjustment procedure given in section 5.4.2.

2. Perform the scan linearity adjustment procedure given in section 5.4.4.

3. Verify proper performance of auto target circuit by placing TARGET switch in AUTO, then:

   a. Increase and decrease scene lighting.

   b. Verify that the VIDEO LVL OVER/UNDER LEDs extinguish each time scene lighting is changed.

12.5 ADJUSTMENTS

Adjustment procedures that can be performed after component replacement or periodically to optimize CCU performance are given in this section. The adjustments used for these procedures are listed in table 12-3 through 12-9. Locations of these adjustments as well as test points are shown in this section and in section XIII, parts lists. The extender-board accessory may be inserted between any of the plug-in circuit boards and its card edge receptacle to make adjustments and test points not located on the front panel more accessible.

CAUTION

Always disconnect ac power before removing or replacing any of the plug-in circuit boards or the power supply assembly.

Unless otherwise stated in the procedure, internal adjustments must be made with the CCU and its related Camera connected together with a cable of the same type and length as the cable used in normal operation. If it is not possible to use a cable of the same length as the one normally used, readjustment of the CABLE DELAY and PHASE control, located on the front panel of the CCU, will be necessary when the

Text continued on page 12-6

Table 12-2. Troubleshooting

SYMPTOM	PROBABLE CAUSE	ISOLATION PROCEDURE
No image appears on tv monitor and POWER ON/OFF LED on the front of the CCU is extinguished.	Burned-out power transformer.	Check T1.
No image appears on tv monitor but POWER ON/OFF LED on front panel of the CCU is glowing.	Defective voltage regulator.	Check +20 V, +5 V, -10 V, +300 V, -100 V and 6.3 V dc regulators on power supply board in the CCU.
	Defective video amplifier stage.	Check for video signal of input terminal (TP1) and output terminal TP-121 on the video board. If video signal is absent at TP1, check continuity of video line in cable from Camera; then check video preamplifier in Camera.
	Scanning beam cut off at Camera.	Check setting of BEAM control on power supply board.
	Target voltage too low.	Check the setting of MANUAL TARGET or AUTO TARGET control on front panel of CCU. Check target control circuits on the power supply board.
Picture at monitor will not lock horizontally and/or vertically.	Amplitude of sync in composite video output signal incorrect.	Adjust sync amplitude to 280 mV with Sync Level control (R131) on video board.
	Lapping over of video peaks into sync area of composite video signal.	Check setting of Setup control (R110) on the video board in the CCU.
Poor contrast between blacks and whites in picture and some snow is present.	Inadequate scene lighting.	Increase illumination on scene.
	Defective video amplifier stage.	Check video preamplifier in the Camera.
Picture has no snow but contrast is poor between blacks and whites.	Insufficient video gain.	Adjust setting of AUTO TARGET or MANUAL TARGET controls on front panel of CCU. Check auto target circuit on power supply board. Check auto white circuit on video board. Enlarge opening of the Camera lens iris.
Ghosts in picture.	Improper termination of video signal cable.	Check that video cable is terminated into 75-ohm load at tv monitor.
Picture brightness not uniform over entire area of raster and/or resolution of details is poor for white and near-white areas of scene.	Insufficient beam current at Camera.	Increase beam current with BEAM control on CCU front panel.
Negative picture.	Polarity of video output signal reversed.	Check optional polarity selector circuit (if installed) on the video board.
	Beam current excessive at Camera.	Reduce beam current with BEAM control on CCU front panel.
	Defective video amplifier stage.	Check video amplifiers in both Camera and CCU.

Table 12-2. Troubleshooting (Cont'd)

SYMPTOM	PROBABLE CAUSE	ISOLATION PROCEDURE
Resolution of details in black and gray areas of picture poor.	Setup incorrect in video signal.	Adjust Setup control on video board in the CCU.
	Defective gamma circuit.	Check jumper position in gamma circuit. Check dc setup controls (R65 or R74 of A501).
Picture has white ring around outer edges.	Target voltage too high at image tube in Camera.	Reduce target voltage with MANUAL or AUTO TARGET control on CCU front panel. If turning down TARGET control makes Camera sensitivity too low, check video gain at Camera and CCU.
Dark horizontal bar rolls vertically through picture and/or the edges of picture are wavy.	Ripple in one or more of the power supply voltages.	Check voltage regulators on power supply board.
Picture has black vertical strip along left edge.	Horizontal blanking in video signal too wide.	Adjust at blanking signal generator.
Picture has vertical strip along right side.	Cable delay compensation incorrect.	Adjust CABLE DELAY control (R16) on front panel deflection board.
Picture has black diagonal lines running through it.	Beam at Camera not being blanked properly during retrace.	Check blanking in Camera.
Highlights in picture have poor detail.	Target at Camera saturates on white peaks of video signal.	Adjust WHITE CLIP control (R51) on the video board front panel.
Entire picture at monitor out of focus.	Scene not focused properly on target at Camera.	Check setting of focus ring on lens.
		Check for proper distance between lens and image tube faceplate at Camera (section 5.4.2).
	Scanning beam not focused properly on target at Camera.	Adjust FOCUS control on front panel of CCU.
		Adjust G3 and G4 voltages on deflection board (A3) in Camera.
		Adjust magnetic focus control in Camera.
Poor resolution between different shades of gray in picture.	Video amplifier response to changes in light levels not properly compensated.	Check setting of gamma controls on the video board.
Picture does not fill out raster at monitor horizontally.	Horizontal deflection signal amplitude too low.	Check setting of HORIZ SIZE control on deflection board front panel.
Picture does not fill out raster at monitor vertically.	Insufficient vertical deflection of scanning beam.	Check setting of VERT SIZE control on deflection board front panel.
Picture compressed at top.	Vertical deflection of scanning beam nonlinear.	Check the vertical deflection circuit on the deflection board (A503) in the CCU for linearity.
Picture compressed or expanded at side.	Horizontal deflection nonlinear.	Check the horizontal deflection circuit on the deflection board (A3) in the Camera for linearity.

Table 12-3. Video Board Adjustments

NAME	CIRCUIT REFERENCE	FUNCTION
Video Peaking	C100	Flattens video response in reverse video
Video Peaking	L11	Provides peaking at 30 MHz
Gain	R6	Sets video gain for input stage
Phase	R14	Adjusts phasing of higher-frequency components in video signal, thus compensating for phase shifts resulting from transmission of the signal through reactive paths
Aperture	R12	Adjusts the amount of high-frequency peaking to improve resolution of fine details in the picture
Streaking	R25	Provides additional gain to correct for black streaking in the video signal
White Peak Clipping	R51	Sets peak white level above which video signal components are clipped to eliminate specular highlights
Gamma dc Set	R65	Adjusts video gain versus light-level response
Black Compression dc Set	R74	Controls the amount of black-level compression
Black Level	R90	Sets up the black level to a nominal value
Reverse Video Setup	R103	Sets up the proper dc voltage level during reverse video condition (optional circuit).
Setup	R110	Adjusts the amount of separation between black peaks and blanking level
Sync Level	R131	Adjusts dc level of sync signal at the video output
Indicator Set	R151	Sets up the desired video voltage that will keep the VIDEO LVL OVER/UNDER LEDs extinguished

Table 12-4. Shading Board Adjustments

NAME	CIRCUIT REFERENCE	FUNCTION
Horizontal Sawtooth	R6	Adjusts amplitude of the horizontal-sawtooth waveform
Horizontal Parabola	R10	Adjusts amplitude of the horizontal-parabolic waveform
Vertical Sawtooth	R86	Adjusts amplitude of the vertical-sawtooth waveform
Vertical Parabola	R90	Adjusts amplitude of the vertical-parabolic waveform
Modulation Bias	R41	Adjust bias on shading modulator at the video board
Black Balance	R46	Selects black- or no-modulation level for video signals being modulated with shading signals

Table 12-5. Deflection Board Adjustments

NAME	CIRCUIT REFERENCE	FUNCTION
Sawtooth Amplifier	R11	Sets a reference used in advancing of horizontal scan to compensate for video signal delays
Cable Delay	R16	Adjusts timing of horizontal scan with reference to leading edge of horizontal sync
Clamp Timing	R32	Adjusts timing of horizontal-clamp pulse with reference to leading edge of horizontal sync
Horizontal Size	R25	Adjusts width of scanning pattern on target at Camera
Vertical Size	R70	Adjusts scanning pattern height on target at Camera
Vertical Center	R67	Adjusts position of scanning pattern up or down at target in Camera
Horizontal Center	R52	Adjusts position of scanning pattern left or right at target in Camera

Table 12-6. Sync Generator Board Adjustments

NAME	CIRCUIT REFERENCE	FUNCTION
Oscillator resonator	L1	Tunes master oscillator when sync generator is used in the line-lock mode
Switch block	S21	Selects counts in 8-bit variable modulus counter; also determines input frequency to this counter
Switch block	S41	Selects desired scan rate
Frequency control	C14	Adjusts frequency of crystal oscillator

Camera is put back into service. For observation purposes a tv monitor in good working condition having a scanning pattern identical to that of the Camera should be connected to one of the VIDEO output terminals at the rear of the CCU.

Adjustment procedures are based on the assumption that composite sync and blanking pulses as specified in table 1-1 are being supplied to circuits in the CCU, either from an internal generator or from an external source. Equipment must be allowed to warm up 15 to 30 minutes after turn on of ac power.

12.5.1 Power Supply Adjustments

WARNING

This equipment operates from line voltage that is dangerous. It could be fatal if contacted. Use extreme care when working with a unit having this voltage exposed.

Table 12-7. Blanking Generator Board Adjustments

NAME	CIRCUIT REFERENCE	FUNCTION
Horizontal-Sawtooth Adjust	R3	Adjusts amplitude of sawtooth waveform in horizontal-advance generator
Horizontal-Advance Timing	R7	Adjusts timing of horizontal blanking in mixed-blanking output signal with reference to horizontal sync in system mixed-sync signal
Horizontal-Blanking Width	R21	Adjusts width of horizontal blanking in mixed-blanking output signal
Vertical-Sawtooth Adjust	R53	Adjusts amplitude of 50 or 60 Hz sawtooth waveform in vertical-advance generator
Vertical-Advance Timing	R64	Adjusts timing of vertical blanking in mixed-blanking output signal with reference to vertical sync in system mixed-sync signal
2:1 Interlace Timing	R73	Adjusts timing of vertical blanking in mixed-blanking output signal for correct 2:1 interlace
Vertical-Blanking Width	R81	Adjusts width of vertical-blanking pulses in mixed-blanking output signal

Table 12-8. Power Supply Board Adjustments

NAME	CIRCUIT REFERENCE	FUNCTION
Beam Adjust	R30	Adjusts beam current at image tube in the Camera
+20 Volt Adjust	R40	Calibrates +20 V dc regulated supply
-10 Volt Adjust	R43	Calibrates –10 V dc regulated supply
Auto Target Adjust	R52	Adjusts light sensitivity of image tube when TARGET AUTO/MAN switch is in AUTO position
Manual Target Adjust	R61	Adjusts light sensitivity of image tube when TARGET AUTO/MAN switch is in MAN positon
Focus Adjust	R62	Adjusts focus of scanning beam on target of image tube at Camera
Fixed Target Adjust	R63	Adjusts for fixed target voltage

Before applying ac power to the CCU verify that the voltage range selection switch (S3) is in the proper position (115 V/230 V) for the line voltage to be used. The POWER ON/OFF switch should be in the OFF position before connecting the unit to ac power. Test points and adjustable controls are shown in figure 12-1. To adjust power supply voltages:

1. Slide the power supply subassembly about halfway out of the subchassis as instructed in section 12.6.3.
2. Set the POWER ON/OFF switch to ON.

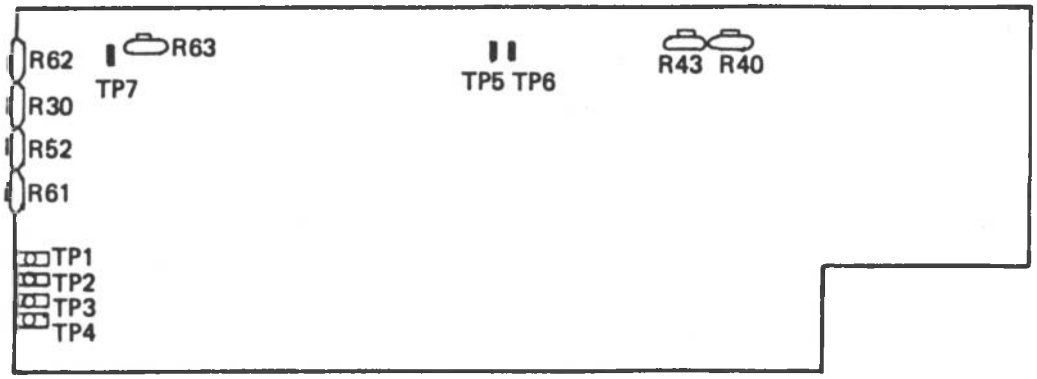


Figure 12-1. Test Points and Adjustments, Power Supply Board (A506A1)

3. Set the voltmeter for measuring +20 V dc.
4. Connect the common lead to the ground test point located on the front panel of the power supply. Connect the voltmeter probe to +20 V (TP3), also located on the front panel of the power supply.
5. Adjust R40 so voltage at TP3 is 20±0.020 V dc.
6. Connect an oscilloscope probe to TP3.
7. Verify that noise and ripple content does not exceed 5 mV p-p.
8. Repeat steps 3 through 7 with the voltmeter set up for -10, +5, +300, and -100 V dc respectively and make the measurements and adjustments in table 12-9.

Table 12-9. Power Supply Voltage and Ripple Limits

TEST POINT	VOLTAGE LIMITS	NOISE AND RIPPLE CONTENT	ADJUST TO	ADJUST WITH
TP1	-9.7 to -10.3 V dc	5 mV p-p max	-10 V dc	R43
TP2	+4.9 to +5.2 V dc	5 mV p-p max	+5 V dc	*
TP6	+285 to +330 V dc	2 V p-p max	+300 V dc	*
TP5	-95 to -110 V dc		-100 V dc	R30

*No adjustment. If voltage, noise, or ripple are outside specifications, repair the faulty circuit.

9. Set the TARGET AUTO/MAN switch to the MAN position.
10. Move the voltmeter probe from TP5 to TP7.
11. Adjust the MANUAL TARGET control (R61), on power supply front panel, to obtain +25±5 V dc.
12. Set the TARGET AUTO/MAN switch to the AUTO position.
13. With the voltmeter probe still on TP7, adjust the AUTO TARGET control (R52), located on the front panel of the power supply, to obtain +25±5 V dc.
14. Set the POWER ON/OFF switch to the OFF position.
15. Return the power supply assembly to its normal operating position in the CCU.

12.5.2 Sync Generator Board Adjustments

The sync generator has one adjustment that tunes the master oscillator when operating with the jumper in the Line Lock (LL) position. Refer to figure 12-2 for location of test points and adjustments.

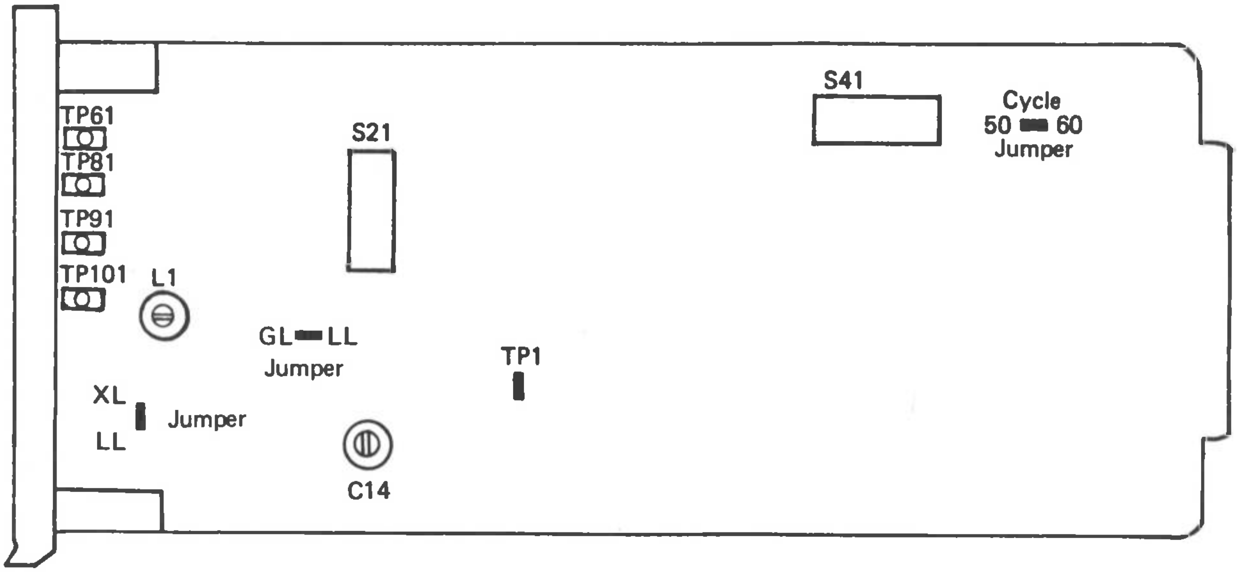


Figure 12-2. Test Points and Adjustments, Sync Generator Board (A504-1)

To make the adjustment use a nonmagnetic screwdriver or tuning tool and proceed as follows:

1. Set the POWER ON/OFF switch to the OFF position.
2. Plug the sync generator onto the extender board and install the pair in the proper position in the CCU.
3. Verify that the GL/LL jumper is in the LL position.
4. Place the XL/LL jumper in the LL position.
5. Set the POWER ON/OFF switch to the ON position.
6. Connect the oscilloscope probe to TP2 and obtain a display.
7. Adjust C14 for a repetition rate of 19.845 MHz.
8. Move the oscilloscope probe from TP2 to TP1.
9. Adjust L1 until the signal is a symmetrical square wave on the oscilloscope.
10. Set the POWER ON/OFF switch to the OFF position.
11. Return the sync generator board to its position in the CCU without the extender board.

12.5.3 Scan Rate Establishment

The 8000 Series CCU and its related Camera are designed to operate at any odd horizontal-line rate from 525 through 1225 lines per frame with 2:1 interlace or 1227 through 1749 lines per frame with 4:1 interlace. However, some scan control adjustments may be required when changing from a low line rate to a high line rate or vice versa. As shipped from the factory the CCU and Camera are adjusted to operate at the line rate requested at time of purchase.

If it is desired to change scan rate, proceed as follows:

1. Set the POWER ON/OFF switch to the OFF position.
2. Remove the sync generator board from the CCU.
3. Locate switch blocks S21 and S41 on the sync generator board (figure 12-2).
4. Set lever 10 on S21 to the ON position to establish an interlace of 2:1 for use with a line rate of 1225 or less, or set S21-10 to the OFF position to establish an interlace of 4:1 when using a higher line rate.

There are two equations to solve for determining the new lever positions (binary count rate) of switches S21 and S41. Use the following equation to solve for X to determine the lever positions of switch S21:

$$X = U - \left(\frac{f'}{y\,z}\right)$$

Where: X = the desired count of the counter

U = the maximum count of the counter, or 256

f' = one half the oscillator frequency (19.845 MHz) for >625 lines/frame or one third the oscillator frequency for ⩽625 lines/frame.

y = the desired lines/frame

z = the field rate (50 or 60 Hz)

For example:
The desired lines/frame is 729.
The field rate is 60 Hz

$$f' = \frac{19.845 \text{ MHz}}{(2)} \qquad \text{since 729 is} > 625 \text{ lines/frame}$$

$$X = 256 - \left(\frac{19.845 \text{ MHz}}{(2)\,(729)\,(60)}\right) = 256 - 227 = 29$$

It is then required to place in the off position those switches that represent a total binary count of 29. All other switches on S21 are left on.

switch	1	binary	1
	3		4
	4		8
switch	5	binary	16
		binary	29 Total

You can verify these required switches from table 12-10 for the 729 scan lines and 60-Hz field rate condition. The above procedure can be used to select any odd horizontal-scan rate within the limits of the counter.

Table 12-10. Sync Generator Board Line Rate Selection

SCAN LINES	FIELD RATES (Hz)	HORIZONTAL SWEEP (Hz)	VERTICAL SWEEP (Hz)	S21 LEVER SETTING										S41 LEVER SETTING									
				1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
525	60	15,750	60	on	off	off	off	on	off	on	on	off	on	on	off	off	on	on	on	on	on	off	on
625	50	15,625	50	on	on	off	off	on	off	on	on	off	on	on	on	on	off	off	off	on	on	off	on
729	60	21,870	60	off	on	off	off	off	on	on	on	on	on	on	on	off	off	on	off	off	on	off	on
875	60	26,250	60	off	off	on	on	on	on	off	on	on	on	off	on	off	on	off	off	on	off	off	on
945	60	28,350	60	off	on	on	on	off	on	off	on	on	on	on	on	on	off	off	on	off	off	off	on
1,023	60	30,690	60	on	off	off	off	off	on	off	on	on	on	off	off	off	off	off	off	off	off	off	on
1,225	60	36,750	60	off	on	on	off	off	off	off	on	on	on	on	on	off	on	on	off	off	on	on	off
Switch S21 and S41 ON position verses scan rate.				1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10

6. Use the following equation to determine the lever positions of switch block S41 when changing the scan rate:

$$C = D-1$$

Where: C = the total required binary count that must be established by setting switches to the off position

D = the desired number of scan lines (must be an odd number) per frame

For example:
The desired lines per frame is 729

$$\begin{aligned} C &= D-1 \\ &= 729-1 \\ &= 728 \end{aligned}$$

Therefore the following switches must be set to off and all others left on:

switch	3	binary	8	
	4		16	
	6		64	
	7		128	
switch	9	binary	512	
		binary	728	Total

7. Return the sync generator board to its position in the CCU.

8. Set the POWER ON/OFF switch to the ON position.

9. Perform the procedures outlined in section 5.4.2, 5.4.4, and 12.5.6 to achieve the best possible picture.

12.5.4 Blanking Generator Adjustments

Adjustments for the blanking generator are shown in figure 12-3. Instructions for adjusting the board are divided into two parts; horizontal and vertical blanking.

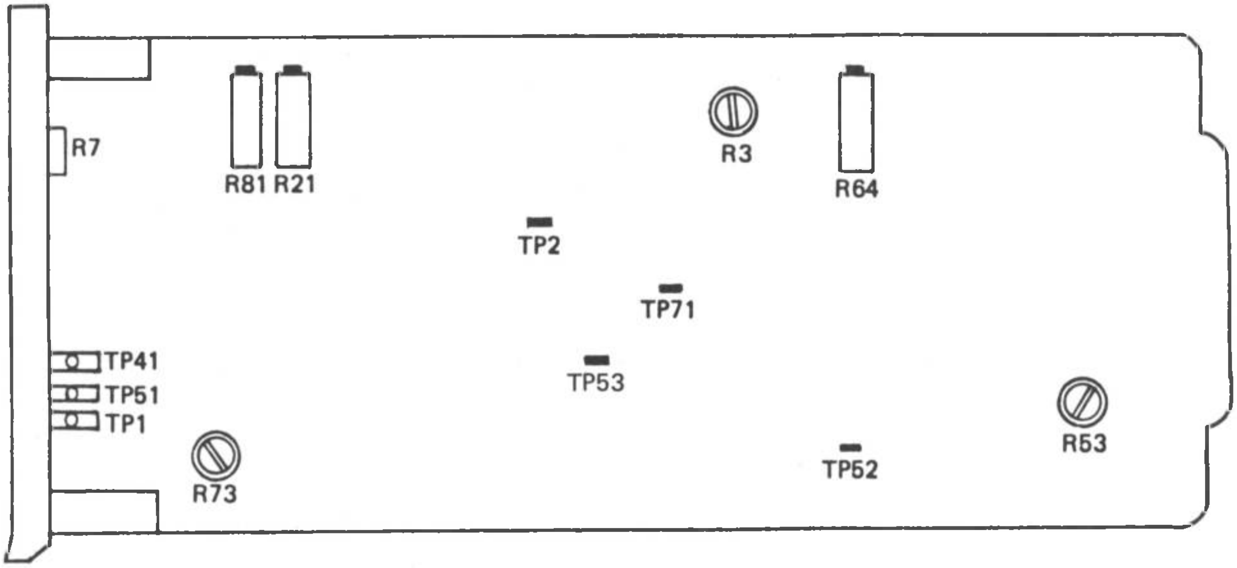


Figure 12-3. Test Points and Adjustments, Blanking Generator Board (A504-2)

12.5.4.1 Horizontal Adjustments

Use the following procedures when adjusting width and timing of the horizontal-blanking output pulses:

1. Set the POWER ON/OFF switch to the OFF position
2. Install the blanking generator on the extender board, then plug the extender board into the receptacle assigned to the blanking generator.
3. Verify that the externally applied sync source conforms to EIA RS-170, RS-330 or RS-343-A specifications at 30 frame 2:1 interlace mixed-sync signal.
4. Set the POWER ON/OFF switch to the ON position.
5. Connect the oscilloscope probe to HORIZ IN (TP1) on the blanking generator board front panel.
6. Verify that the positive-going leading edge of the horizontal-trigger input pulse at TP1 starts just after the leading edge of horizontal blanking in the composite blanking signal. If not, correct the timing of the horizontal-trigger pulse on the deflection board (A503), section 12.5.5.
7. Move the oscilloscope probe from TP1 to TP2.
8. Adjust the amplitude of the sawtooth waveform to 5.5±0.5 V p-p with R3.
9. Using a dual-trace oscilloscope, connect one probe to BLANK OUT (TP41) and the other to the test point labeled SYNC IN, located on the front panel of the deflection board (A503).

10. Adjust the horizontal-advance (HORIZ ADV) control (R7) so that the leading edge of the horizontal-blanking pulse is advanced in timing with reference to the leading edge of horizontal sync in the system mixed-sync signal by 1.6 μs in a 525-line system or 0.85 μs in systems with higher line rates.

11. With the oscilloscope probe at TP41, adjust the horizontal-blanking width (H. Blk Width) control (R21) so the width of the horizontal-blanking pulse is correct for the horizontal-line rate being used in the system, as specified in table 1-1.

12.5.4.2 Vertical Adjustments

Use the following procedure when adjusting the width and timing of vertical-blanking pulses in the mixed-blanking output signal:

1. Move the oscilloscope probe from TP41 to VERT IN (TP51), located on the blanking generator front panel.

2. Adjust amplitude of the sawtooth waveform at TP51 to 5.5±0.5 V p-p with R53.

3. Using a dual-trace oscilloscope, connect one probe to TP53 and the other probe to the test point labeled SYNC IN located on the front panel of the deflection board (A503).

4. Adjust the vertical-advance control (R64) to make the waveform conform with the following:

   - In 525-line EIA RS-170 systems (figure 8-3) the pulse should start ¼ line before the first equalizing pulse preceding vertical sync.
   - In 525-line EIA RS-330 systems (figure 8-4) the pulse should start ¼ line before the third equalizing pulse preceding vertical sync.
   - In 675- to 875-line systems, the pulse should start ¼ line before the second horizontal-sync pulse preceding the first equalizing pulse. (If there are no equalizing pulses, use the fifth horizontal pulse preceding the vertical sync.)
   - In 875-to-945-line systems, the pulse should start ¼ line before the sixth horizontal-sync pulse preceding vertical sync.
   - In 1023-to-1225-line systems, the pulse should start ¼ line before the third horizontal-sync pulse preceding the first equalizing pulse. (If there are no equalizing pulses, use the sixth horizontal-sync pulse preceding the vertical sync.)

5. Connect both probes of a dual-trace oscillosocpe to TP71. Set up the oscillosocpe so that horizontal sweep triggers on alternate fields.

6. Adjust R73 so the two alternate fields displayed coincide in timing.

7. Move one of the probes of the dual-trace oscilloscope to TP41 and the other probe to the test point labeled SYNC IN located on the front panel of the deflection board (A503).

8. Adjust the vertical blanking width (V. Blk Width) control (R81) so width of vertical-blanking pulses at TP41 are 21 horizontal lines for 525-line system or 1250±100 μs for 675-through 1225-line system.

9. Adjust the vertical-advance control (R64) so vertical-blanking pulse starts:
   - 1.6 μs before the first equalizing pulse in 525-line EIA RS-170 systems
   - 1.6 μs before the third horizontal-sync pulse preceding vertical sync in 525-line EIA RS-330 systems
   - 0.85 μs before vertical sync in 675- through 1225-line EIA RS-343-A systems
10. Set the POWER ON/OFF switch to the OFF position.
11. Remove the blanking generator board from the extender board and replace each board in its assigned position in the CCU.

12.5.5 Deflection Board Adjustments

Test points and adjustments of the deflection board are shown in figure 12-4.

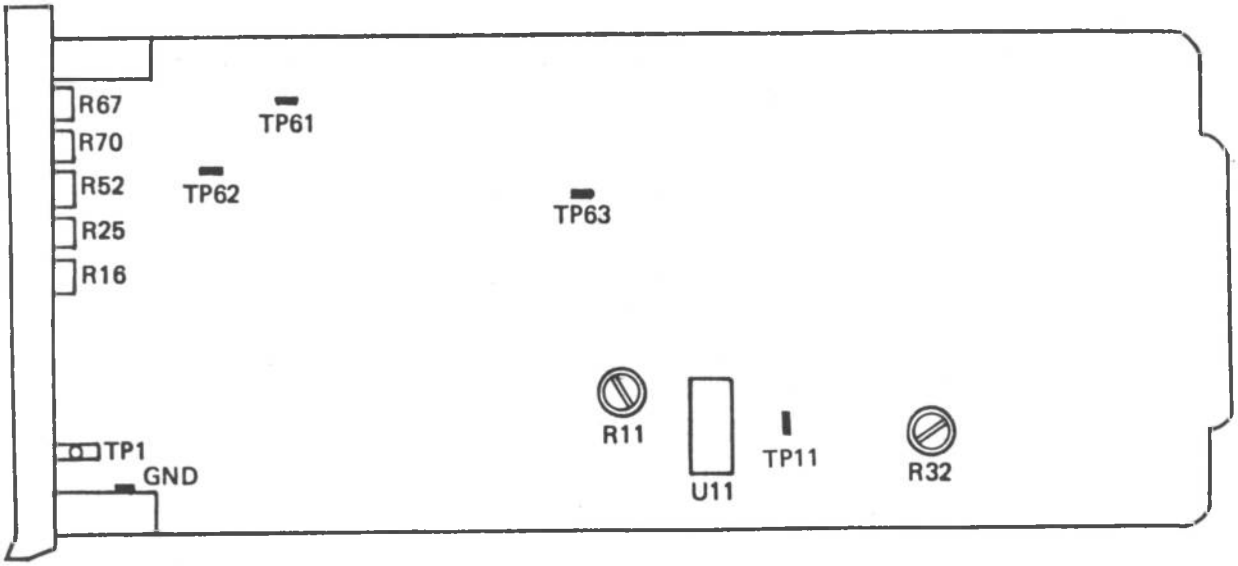


Figure 12-4. Test Points and Adjustments, Deflection Board (A503)

To make adjustments on the deflection board, proceed as follows:

1. Install deflection board on the extender board and install the pair in the deflection-board position (J3).
2. Set the POWER ON/OFF switch to the ON position.
3. Connect the oscilloscope probe to TP11.
4. Adjust the sawtooth amplifier (Saw Amp) control (R11) for a 10 μs positive-going pulse at the horizontal rate.

5. Using a dual-trace oscilloscope, connect one probe to the test point labeled SYNC IN (TP1) on the front panel of the deflection board. Connect the other probe to the BLANK IN or BLANK OUT connector, located on the rear panel of the CCU.

6. Adjust the CABLE DELAY control (R16), located on the front panel of the deflection board, so horizontal retrace in the video signal at TP1 starts just after the leading edge of horizontal blanking in the composite blanking signal at the BLANK IN or BLANK OUT connector.

7. Adjust the clamp timing control (R32) to eliminate any horizontal white streaks in the picture on the monitor raster; if this does not completely eliminate all streaks also readjust the CABLE DELAY control R16.

8. Set the POWER ON/OFF switch to the OFF position.

9. Remove the extender board from between the deflection board and the CCU and replace each board in its assigned location in the CCU.

12.5.6 Aspect Ratio Adjustments

Unless otherwise specified at the time of purchase, a CCU shipped from the factory is set up to have a scanning pattern with an aspect ratio of 4:3 width to height. Other aspect ratios, such as 1:1 or 3:4, can be attained by adjusting the height and width of the area scanned at the target in the image tube. However, it should be emphasized that a change of aspect ratio cannot always be made with a used image tube, as the previously scanned and unscanned areas will have different sensitivities and dark current. For proper perspective of the scene being televised, a tv monitor must have the same aspect ratio as the Camera and CCU. Setting aspect ratios other than 4:3 requires that an alignment chart be made for the desired aspect ratio. This procedure assumes a standard 4:3 chart is being used.

To adjust aspect ratio proceed as follows:

1. Place the Camera in a test jig as described in section 5.4.4 steps 4 through 7.

NOTE

> Before making the adjustments in step 2 verify that the optical axis of the Camera lens is perpendicular to and centered on the chart.

2. Center the picture on the monitor by adjusting the HORIZ CENT and VERT CENT controls, located on the front panel of the deflection board.

3. Adjust the height of the scanning pattern, using the VERT SIZE control (located on the front panel of the deflection board) so the points of arrows along the top and bottom edge of the linearity chart just touch or slightly overlap edges of the monitor raster.

4. Adjust width of the scanning pattern, using the HORIZ SIZE control (located on the front panel of the deflection board), so the points of arrows along the side edges of the linearity chart just touch or slightly overlap edges of the monitor raster.

5. Adjust to correct nonlinearity as instructed in section 5.4.4.

12.5.7 Video Board Adjustments

Adjustment procedures on the video board have been divided into four sections:

- Video Gain Adjustments, 12.5.7.1
- Gamma Correction Adjustments, 12.5.7.2
- Video Bandwidth Adjustments, 12.5.7.3
- White-Peak Clip Adjustments, 12.5.7.4

Figure 12-5 shows typical composite video output signal parameters. Refer to this figure when making video board adjustments. Test points and adjustable controls on the video board are shown in figure 12-6.

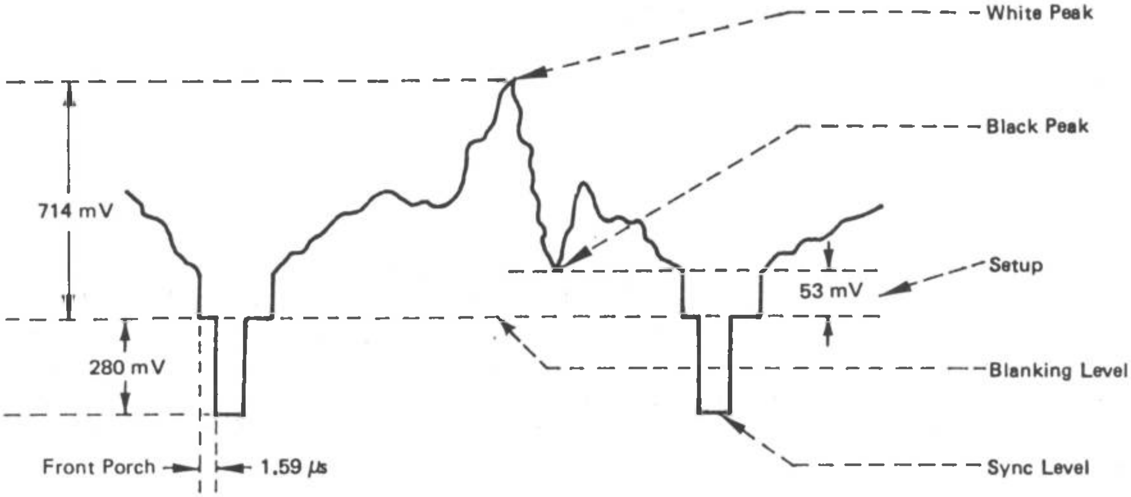


Figure 12-5. Composite Video Output Signal

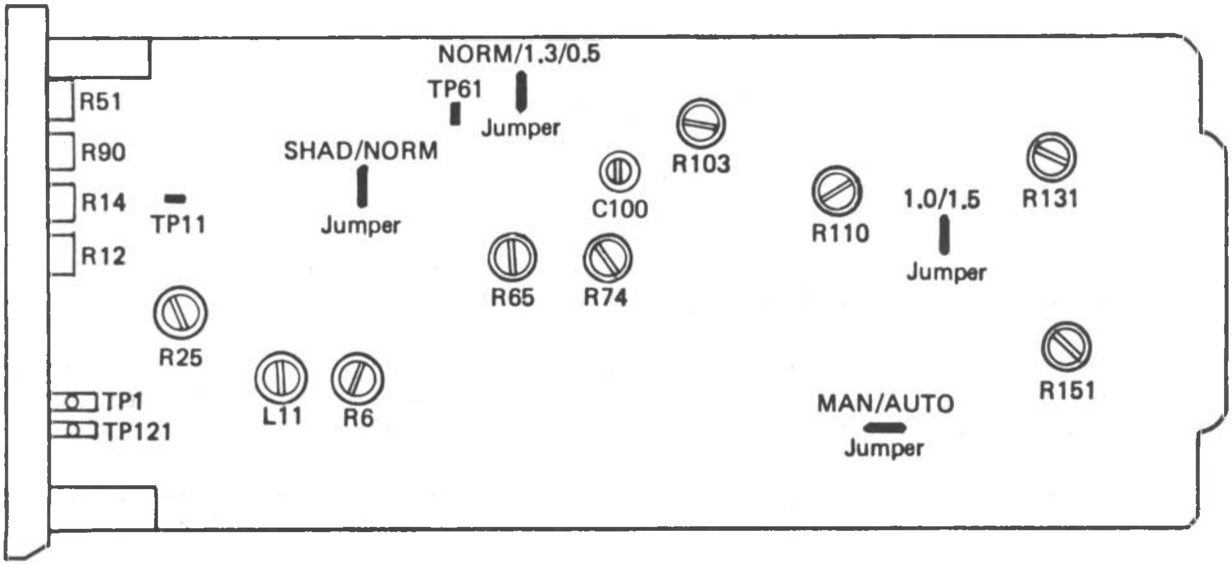


Figure 12-6. Test Points and Adjustments, Video Board (A501)

12.5.7.1 Video Gain Adjustments

1. On the CCU front panel, set the POWER switch to OFF.

2. Install the video board on the extender board and plug the pair into the video board position (J1).

3. On the video board, put jumpers in the following positions:

(AUTO/MAN)	AUTO	(Auto Black)
(0.5/NORM/1.3)	NORM	(Gamma)
(NORM/SHAD)	NORM	(Shading)
(1.0/1.5)	1.0	(Output Level)

4. On the video board adjust potentiometers as follows:

Gain (R6)	ccw
Streaking (R25)	ccw
BLACK LEVEL (R90)	midrange
WHITE CLIP (R51)	ccw
APERTURE (R12)	ccw
PHASE (R14)	ccw
Setup (R110)	ccw
Sync (R131)	cw

5. On the CCU front panel set the TARGET AUTO/MAN switch to MAN.

6. On the CCU front panel, set the POWER switch to ON.

7. On the CCU front panel, adjust the BEAM and TARGET controls to obtain the best possible picture on the tv monitor.

8. Connect an oscilloscope probe to TP1 on the video board front panel.

9. Adjust the lens aperture to achieve a video signal of 300 mV p-p at TP1.

10. Move the oscilloscope probe from TP1 to TP11 on the video board (A501) in the CCU.

11. On the CCU video board, adjust the gain control (R6) to obtain 1.05 V p-p at TP11.

12. Cover the lens of the Camera with a lightproof cap.

13. Move the oscilloscope probe from TP11 to TP61.

14. On the CCU video board, adjust the BLACK LEVEL control (R90) for 0 V dc.

15. Remove the lightproof cap from the Camera lens.

16. Verify a voltage level at TP61 of 650 mV.

17. Move the oscilloscope probe from TP61 to TP121.

18. Adjust the setup control (R110) so the blackest portion of the signal is 53 mV above blanking.

19. Adjust the sync level control (R131) for a sync level of 280 mV at TP121.

20. With the oscilloscope probe still on TP121, verify a 1.0 V p-p video output signal.

21. Adjust the indicator level control (R151), to extinguish both indicator LEDs located on the front panel of the video board.

22. On the CCU front panel, set the POWER switch to OFF.

23. Remove the extender board from between the video board and its card edge connector and replace both boards in their assigned locations.

12.5.7.2 **Gamma Adjustments** – The video board (A502) can be set up to operate with a gamma of 0.5, 1.3, or without correction. If it is necessary to adjust or change the gamma setting use one of the following procedures:

12.5.7.2.1 *0.5-Gamma Adjustments* –
12.5.7.2.2 *Normal-Gamma Adjustments* –
12.5.7.2.3 *1.3-Gamma Adjustments* –

12.5.7.2.1 *0.5-Gamma Adjustments* – To adjust for a gamma of 0.5 perform the following steps:

1. On the CCU front panel, set the POWER switch to OFF.

2. Install the video on the extender board and plug the pair into the video board position (J1).

3. Move the gamma (0.5/NORM/1.3) jumper to 0.5.

4. Set the POWER switch to ON.

5. Connect the oscilloscope probe to TP121 on the video board.

6. Adjust the black composition dc set (Black Comp Dc Set), control (R74) to obtain a video signal of 1.0 V p-p at TP121.

12.5.7.2.2 *Normal-Gamma Adjustments* – To adjust for normal-gamma proceed as follows:

1. On the CCU front panel, set the POWER switch to OFF.

2. Install the video board on the extender board and plug the pair into the video board position (J1).

3. Move the gamma (0.5/NORM/1.3) jumper to NORM.

4. Set the POWER switch to ON.

5. Cover the Camera lens with a lightproof cap.

6. Connect the oscilloscope probe to TP61.

7. Adjust the BLACK LEVEL control, located on the front panel of the video board, for zero volts at TP61.

8. Remove the lightproof cap from the Camera lens.

9. Verify that the voltage at TP61 is now 650 mV p-p.

10. Move the oscilloscope probe from TP61 to TP121.
11. Readjust the setup control (R110), if necessary so that the blackest portion of the video output signal is 53 mV above blanking level.
12. On the CCU front panel, set the POWER switch to OFF.
13. Remove the video board from the extender board and replace both boards in their assigned position in the CCU.

12.5.7.2.3 *1.3-Gamma Adjustments* – To adjust for a gamma of 1.3 proceed as follows:

1. On the CCU front panel, set the POWER switch to OFF.
2. Install the video board on the extender board and install the pair in the video board position (J1).
3. Move the gamma (0.5/NORM/1.3) jumper to the 1.3 position.
4. Connect the oscilloscope probe to TP61 on the video board.
5. Set the POWER switch to ON.
6. Adjust the BLACK LEVEL control, located on the front panel of the video board, to achieve a 1.0 V p-p signal.
7. Move the oscilloscope probe from TP61 to TP121.
8. Adjust the gamma dc-set control (R65) so the blackest portion of the signal is 53 mV above blanking level at TP121.
9. Remove the video board from the extender board and replace both boards in their assigned position in the CCU.

12.5.7.3 **Video Bandwidth Adjustments** – Before starting the following procedure, verify that video gain and bandwidth adjustments of the video preamplifier board (A4) in the Camera are properly set up (refer to section 5.4.3).

To adjust the video bandwidth:

NOTE

> Response of the video amplifier in the Camera should be flat to within 0.1 dB per MHz from 100 kHz up to 32 MHz; the video signal at the Camera output terminal should have an amplitude of 200 mV p-p.

1. On the CCU front panel, set the POWER switch to the OFF position.
2. Set up test equipment as described in section 5.4.3 and figure 5-3 with exception of spectrum analyzer.

3. Ensure that the video board is plugged directly into the CCU and not installed on the extender board.

NOTE

To make test points and adjustments more accessible, the sync generator board and the deflection board may be removed as long as black level is maintained. Refer to figure 12-5.

4. Set amplitude of the sweep-frequency generator to 20 dB below 1 volt.

5. Connect the oscilloscope probe to TP61 on the video board.

6. Adjust the BLACK LEVEL control, located on the front panel of the video board, to bring the sweep level up out of the base line or down out of the white level at TP61.

7. Set the APERT (aperture) control, located on the front panel of the video board, fully cw.

NOTE

There are no frequency response controls in the normal video path, except APERT and PHASE controls, both located on the front panel of the video board. Capacitor C100 is adjusted for a flat response in reverse video applications.

8. Set amplitude of the sweep-frequency generator to 30 dB below 1 volt.

9. Adjust the PHASE control, located on the video board front panel, and L11 for the flattest possible sweep signal response up to the high end of the video bandpass (8 MHz, 16 MHz, or 32 MHz).

10. On the CCU front panel, set the POWER switch to the OFF position.

11. Disconnect the test equipment and replace the deflection and sync boards.

12.5.7.4 White-Peak Clip Adjustment – Unless otherwise requested by the customer at the time of purchase, the video board is adjusted at the factory so no white-peak clipping of the video signal occurs within the specified range of video output level. If the majority of scenes to be televised have a high incidence of specular highlights, however, some white-peak clipping may be desirable. To establish this:

1. Set the POWER switch to OFF.

2. Install the video board on the extender board and plug the pair into the video board position (J1).

3. Put the Camera into operation and focus on any reasonably well lighted scene.

4. Connect the oscilloscope probe to the test point labeled VIDEO OUT on the front panel of the video board.

5. Set the TARGET AUTO/MAN switch, located on the CCU front panel, to MAN.

6. Verify that the video amplitude and blanking levels are correct, as shown in figure 12-5.

7. Adjust the MANUAL TARGET control, located on the front panel of the CCU, cw to make the video signal amplitude about 40 percent greater than normal.

NOTE

The white-peak clipping level used in step 8 is arbitrarily selected. Some applications may require other clipping levels.

8. Adjust the WHITE CLIP control, located on the front panel of the video board, so the video signal clips on white peaks that are 20 percent greater in amplitude than normal.
9. Set the POWER switch to OFF.
10. Remove the extender board from between the video board and its card edge connector and replace both boards in their assigned locations in the CCU.
11. Resume normal operation of the Camera or proceed to shading board adjustments if a complete CCU alignment is being performed.

12.5.8 Shading Board Adjustments

Adjustable controls on the shading board are shown in figure 12-7.

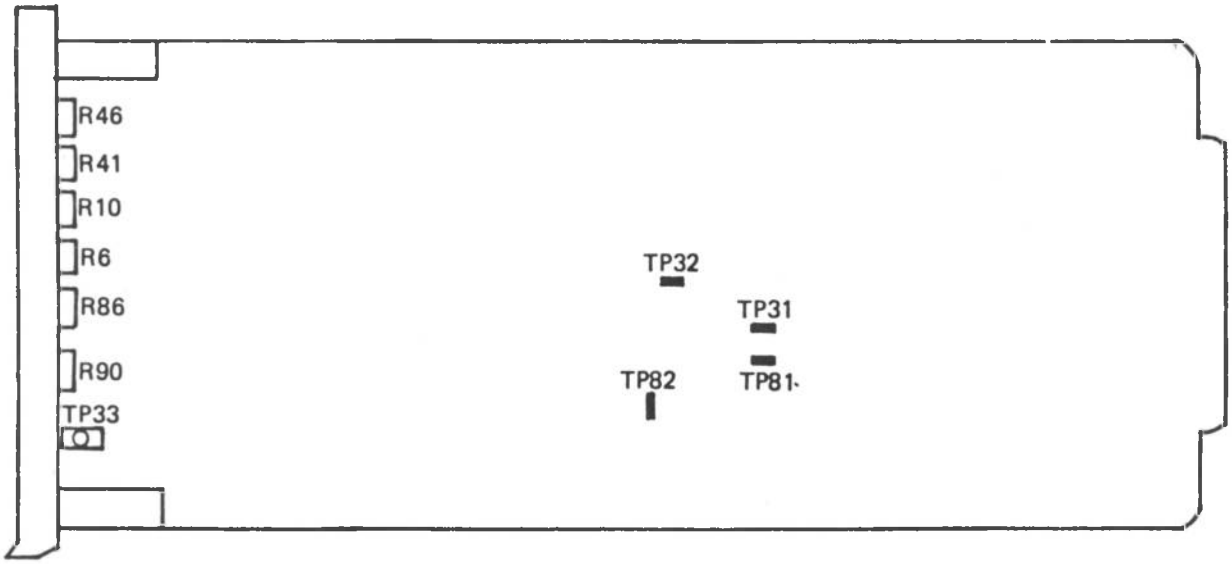


Figure 12-7. Test Points and Adjustments, Shading Generator Board (A502)

Sawtooth and parabolic waveforms associated with this board can be adequately adjusted without the aid of test equipment. Only a tv monitor in good adjustment is required. These adjustments are described in table 12-11. For an instrument adjustment of the shading board use the following procedure:

1. On the CCU front panel, set the POWER switch to OFF.
2. Install the shading board on the extender board; install in the shading board position (J2).
3. Move the NORM/SHAD jumper, located on the video board (A501), to the NORM position.

Table 12-11. Shading Board Adjustments

1 HORIZ SAW	Adjust to correct lighting difference horizontally ↔ on the tv monitor picture.
2 VERT SAW	Adjust to correct lighting difference vertically ↕ on the tv monitor picture.
3 HORIZ PRB	Adjust to correct the lighting differences from the center of the picture to the left and right edges. ←○→
4 VERT PRB	Adjust to correct the lighting differences from the center of the picture to the top and bottom edges. ↑○↓
5 MOD BIAS	Adjustment requires the use of special test equipment. Follow the procedure in section 12.5.8.
6 BLACK BAL	Adjustment requires the use of special test equipment. Follow the procedure in section 12.5.8.

Continue the first four adjustments until the picture appears evenly illuminated.

4. Install a waveform monitor in the video line between the CCU and the tv monitor.

NOTE

If a waveform monitor is not available, connect the video output from the CCU to the oscilloscope vertical input.

5. Place a standard IRE scale over the face of the waveform monitor (or oscilloscope).
6. Adjust gain of the waveform monitor (or oscilloscope) so that 140 IRE units is 1.0 Vp-p.
7. Put the Camera into operation facing a flat, evenly illuminated white scene.
8. Set the MOD BIAS (modulation bias) control, located on the shading board front panel, to mechanical midrange.
9. Adjust the HORIZ SAW, HORIZ PRB, VERT SAW, and VERT PRB controls, located on the front panel of the shading board, to flatten the waveform as much as possible.
10. Adjust the BLACK LEVEL control, located on the video board front panel, for a reference black level of 7.5 IRE units.
11. Adjust the Camera lens or target voltage for a reference white level of 100 IRE units.
12. Place the NORM/SHAD jumper, located on the video board (A501), in the SHAD position.
13. Adjust the MOD BIAS control, located on the front panel of the shading board, to bring the video reference white level back to 100 IRE units.
14. Cover the Camera lens with a lightproof cap.
15. Adjust the BLACK BAL control, located on the front panel of the shading board, for minimum modulation of black level when rotating the VERT PRB control through its range.

16. Remove the lightproof cap from the Camera lens.
17. Aim the Camera at a flat, evenly illuminated white scene.
18. Readjust the HORIZ SAW, VERT SAW, HORIZ PRB, and VERT PRB controls, located on the shading board front panel, for the flattest possible video signal.
19. Return the Camera and CCU to service. If adjustments were being performed in sequence, the Camera and CCU should now be fully adjusted.

12.5.9 Troubleshooting and Maintenance Procedure

Steps in the following procedure are presented in a particular order to ensure optimum Camera and CCU performance. Use this procedure for isolating a malfunction in the Camera and/or CCU.

1. Set the POWER ON/OFF switch to the OFF position.
2. Remove the cover from the Camera, as described in section 5.5.1.
3. Set the POWER ON/OFF switch to the ON position.
4. Follow the adjustment procedure in section 12.5.1 to verify a properly functioning power supply.
5. If the optional sync generator board is installed follow the procedure in section 12.5.2 to verify correct sync signal, otherwise proceed to step 6.
6. If external sync is used verify that the signal conforms to the specifications in table 1-1.
7. Verify voltages on the deflection board (A3) in the Camera, as described in section 5.4.1.
8. If the optional blanking generator board is installed, follow the procedure in section 12.5.4 to verify proper blanking.
9. On the CCU front panel set the TARGET AUTO/MAN switch to AUTO.
10. Adjust for correct aspect ratio, if necessary, as described in section 12.5.6.
11. Adjust focus as described in section 3.1 and section 10.
12. Adjust for proper video levels as described in section 12.5.7.1.

NOTE

A reasonable picture should now be present on the tv monitor.

13. Follow the procedure in section 5.4.3 to adjust video bandwidth in the Camera.
14. Follow the procedure in section 12.5.7.3 to adjust video bandwidth in CCU.
15. Follow the procedure in section 5.4.4 to adjust scan linearity.
16. Follow the procedure in section 12.5.7.4 to verify correct white-peaking clipping.

17. Follow the procedure in section 12.5.5 to adjust the CCU deflection board.
18. Follow the procedure in section 12.5.8 to adjust for proper shading if the optional shading board is installed.
19. Verify a sharp clear picture on the tv monitor.

NOTE

The VIDEO LVL OVER/UNDER indicator LEDs should both be extinguished.

20. On the CCU front panel set the TARGET AUTO/MAN switch to MAN.
21. Perform the adjustments outlined in table 10-1 to extinguish both video level indicator LEDs.
22. Set the POWER ON/OFF switch to OFF.
23. Replace the Camera cover.

12.6 SUBASSEMBLY REMOVAL, REPAIR AND REPLACEMENT

The CCU is designed to allow easy access to all circuits for testing, adjustments, and repair. Circuits are installed on three etched-circuit boards, in a basic unit, four if the sync or blanking generator option is included, and five if the shading board option is also included. All these circuit boards, with exception of the power supply, plug into mating receptacles on a subchassis interconnect board at the rear of the CCU (figure 13-21).

Observe the following when working on the CCU:

1. When removing or replacing any of the circuit boards always disconnect ac power.
2. When replacing components, use only the replacement parts, or equivalents, specified in the section XIII parts lists.
3. Maintain all electrical connections in accordance with the schematic diagrams in section XIV.
4. When a component must be replaced, prevent damage to circuit boards by removing solder with a 35 watt or lighter duty soldering iron and solder wick.
5. When making solder connections, use 60 percent lead, 40 percent tin rosin-core solder. Do not use acid solder flux.

12.6.1 Plug-in Circuit Board Removal

To remove a plug-in circuit board:

1. Lift up on the card ejector handle.
2. Pull the board out of the chassis.
3. Replace the plug-in board by lining it up in the guide slots of the chassis and sliding it into the interconnect board card edge connector.
4. Lock the board into place by lowering the ejector handle.

12.6.2 Extender Board Use

The extender board assembly (figure 12-8) is supplied as standard equipment with the CCU. It is stored in the chassis position (J5) next to the power supply assembly. The extender board is removed from the chassis in the same way as plug-in boards described in paragraph 12.6.1.

To use the extender board proceed as follows:

1. Remove the extender board from the CCU.
2. Separate the extender board from the card support by compressing the split end of the four stand-

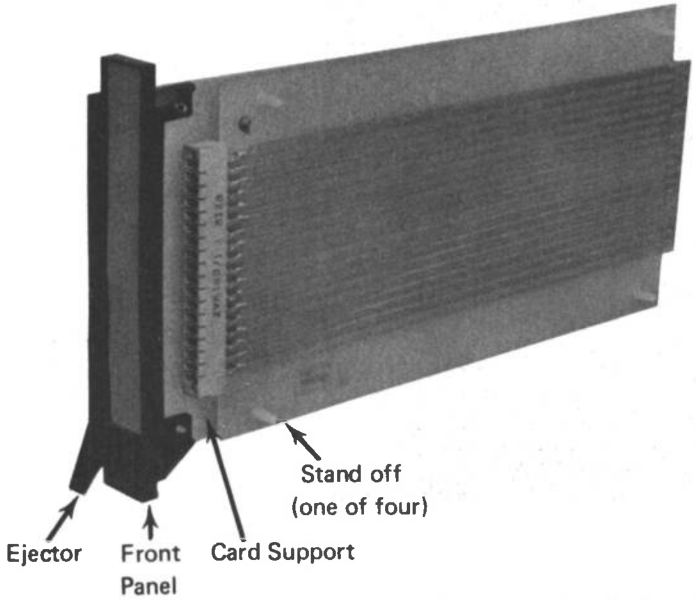


Figure 12-8. Extender Board (A505) Features

offs and pull the extender board free.

3. Use the extender board by inserting it between any of the plug-in circuit boards and the circuit board card edge connector on the interface board.
4. Reassembly is done in reverse order. Return the extender board to its storage position when not in use.

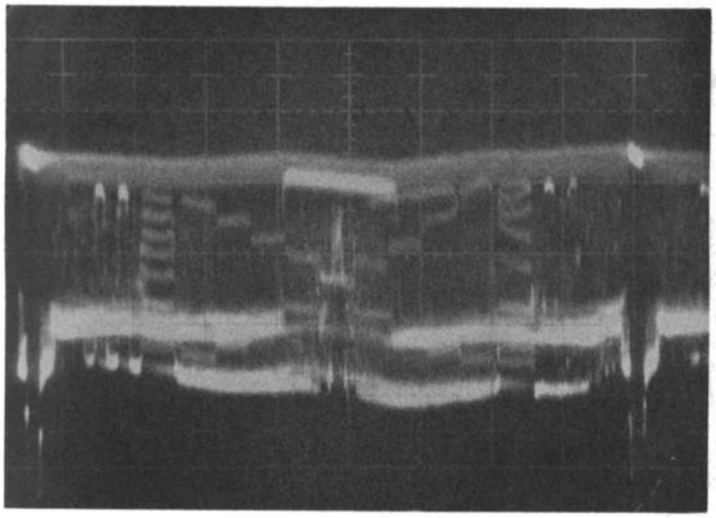
12.6.3 Power Supply Assembly Removal

The power supply is held in place by three screws located on the rear of the CCU (figure 13-2). To remove the power supply proceed as follows:

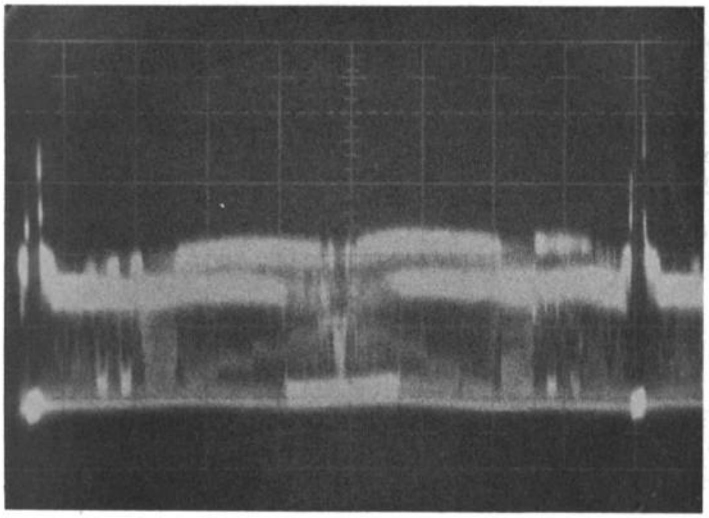
1. Remove the three screws, using a No. 2 flat-blade screwdriver.
2. Slide the power supply out of the chassis.
3. Disconnect the flat connection cable.
4. To install the power supply line it up in the guide slots of the chassis and reconnect the flat connection cable.
5. Slide the power supply into the chassis and install the three screws.

12.7 WAVEFORMS

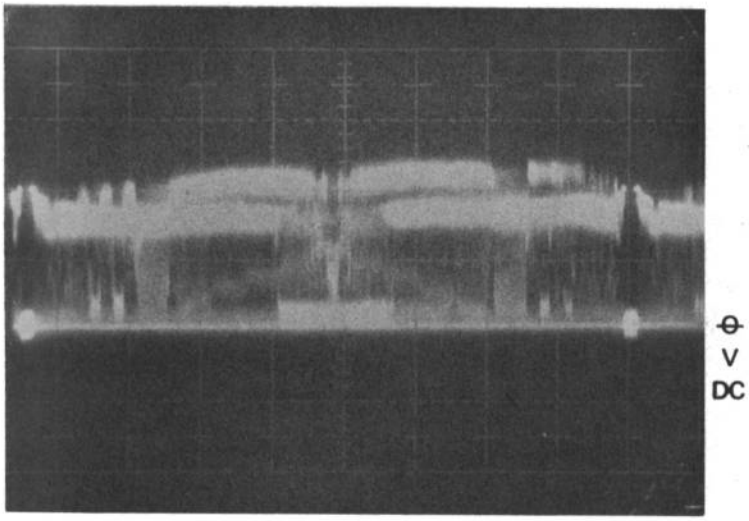
Figures 12-9 through 12-11 illustrate typical waveforms for circuits contained within the CCU. These waveforms were taken at test points throughout the circuits with the Camera monitoring a resolution chart. Waveforms present for some circuits may vary with different control settings, so an interpretation of circuit action is important when using these waveforms for maintenance.



TP1
0.1 V/cm 2 ms/cm

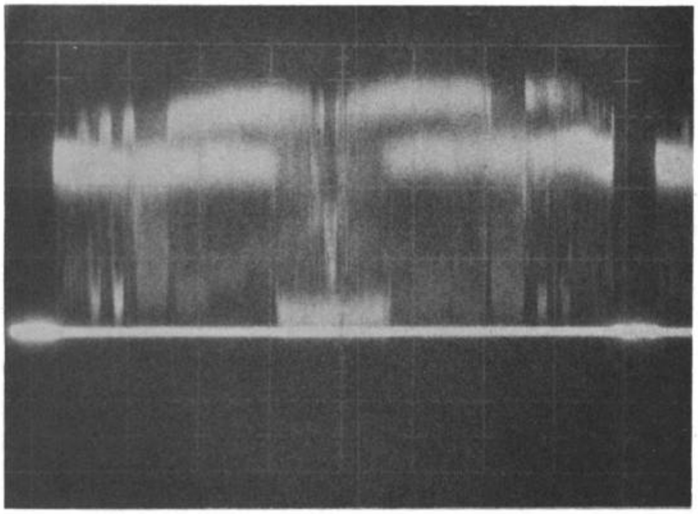


TP11
0.5 V/cm 2 ms/cm

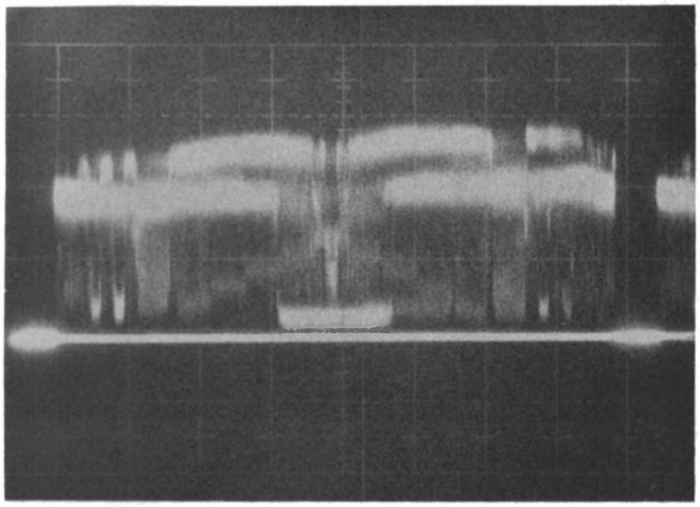


TP31
0.5 V/cm 2 ms/cm

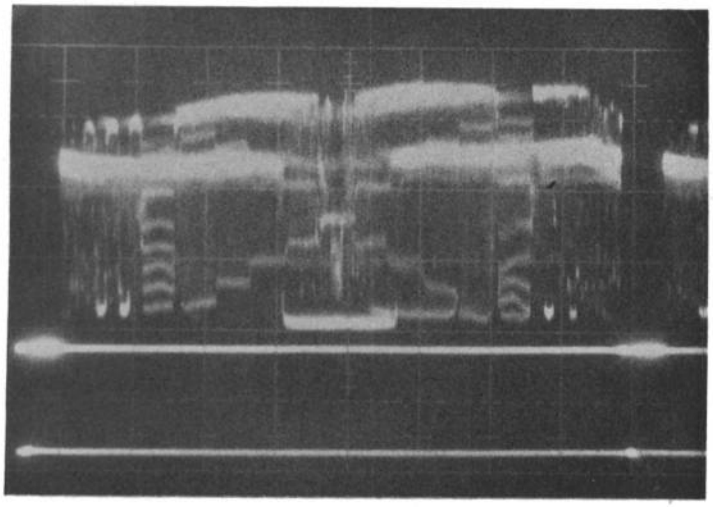
Figure 12-9. Waveforms, Video Board (A501)
(Sheet 1 of 2)



TP61
0.2 V/cm 2 ms/cm

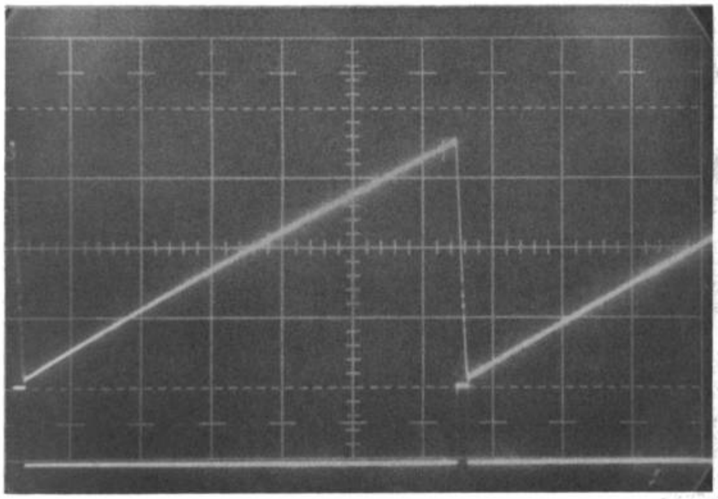


TP101
0.2 V/cm 2 ms/cm



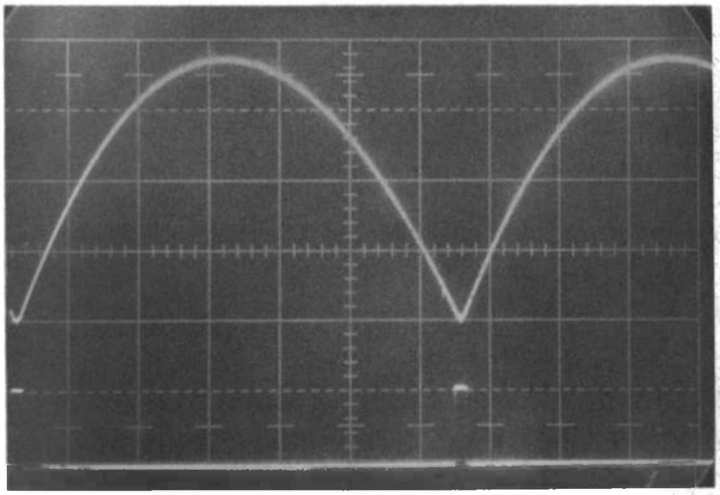
TP121
0.2 V/cm 2 ms/cm

Figure 12-9. Waveforms, Video Board (A501)
(Sheet 2 of 2)



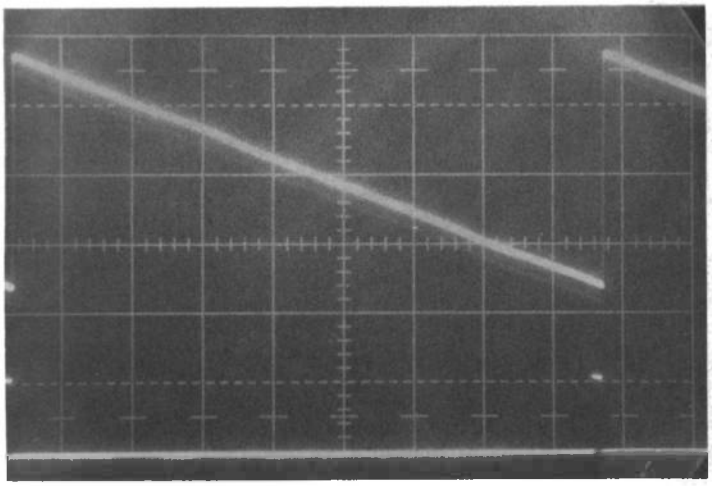
TP31
2 V/cm 10 μs/cm

Clamp In
10 V/cm 10 μs/cm



TP32
2 V/cm 10 μs/cm

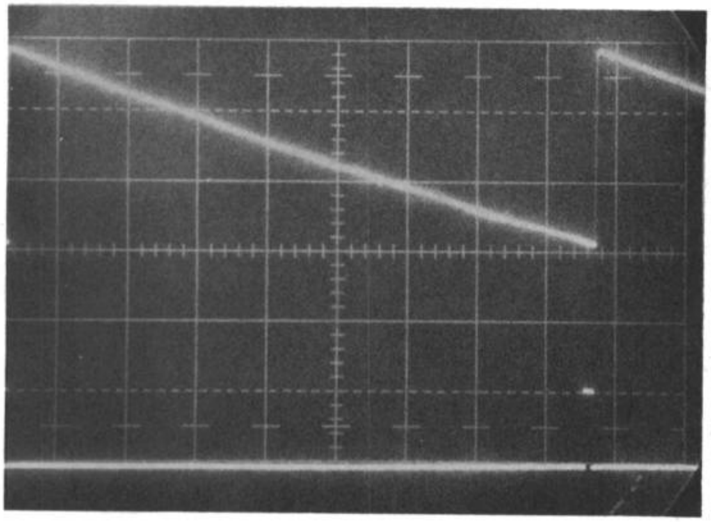
Clamp In
10 V/cm 10 μs/cm



TP33 (R86 full cw all others nulled)
0.2 V/cm 2 ms/cm

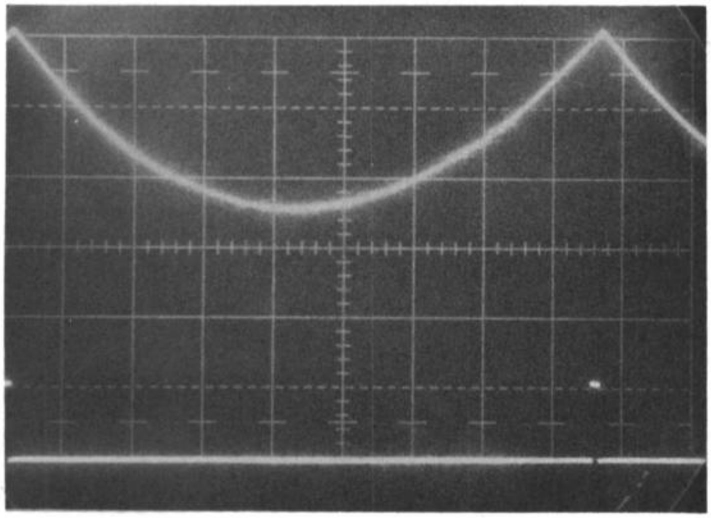
V Trigger
10 V/cm 2 ms/cm

Figure 12-10. Waveforms, Shading Generator Board (A502)
(Sheet 1 of 2)



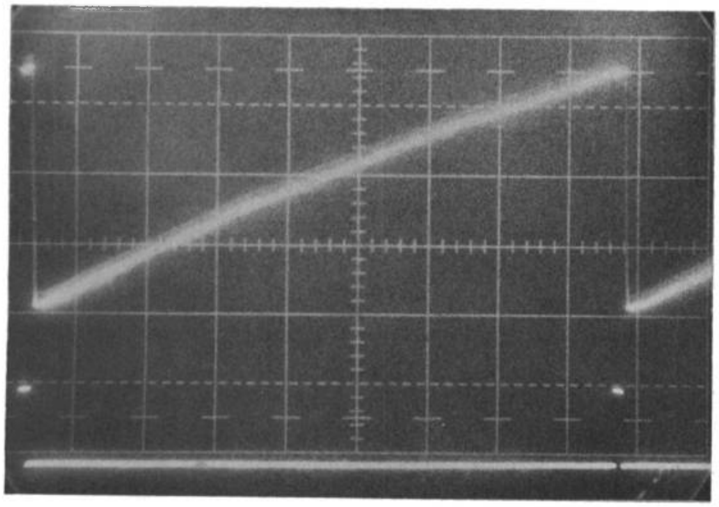
TP81
2 V/cm 2 ms/cm

V Trigger In
10 V/cm 2 ms/cm



TP82
2 V/cm 2 ms/cm

V Trigger In
10 V/cm 2 ms/cm

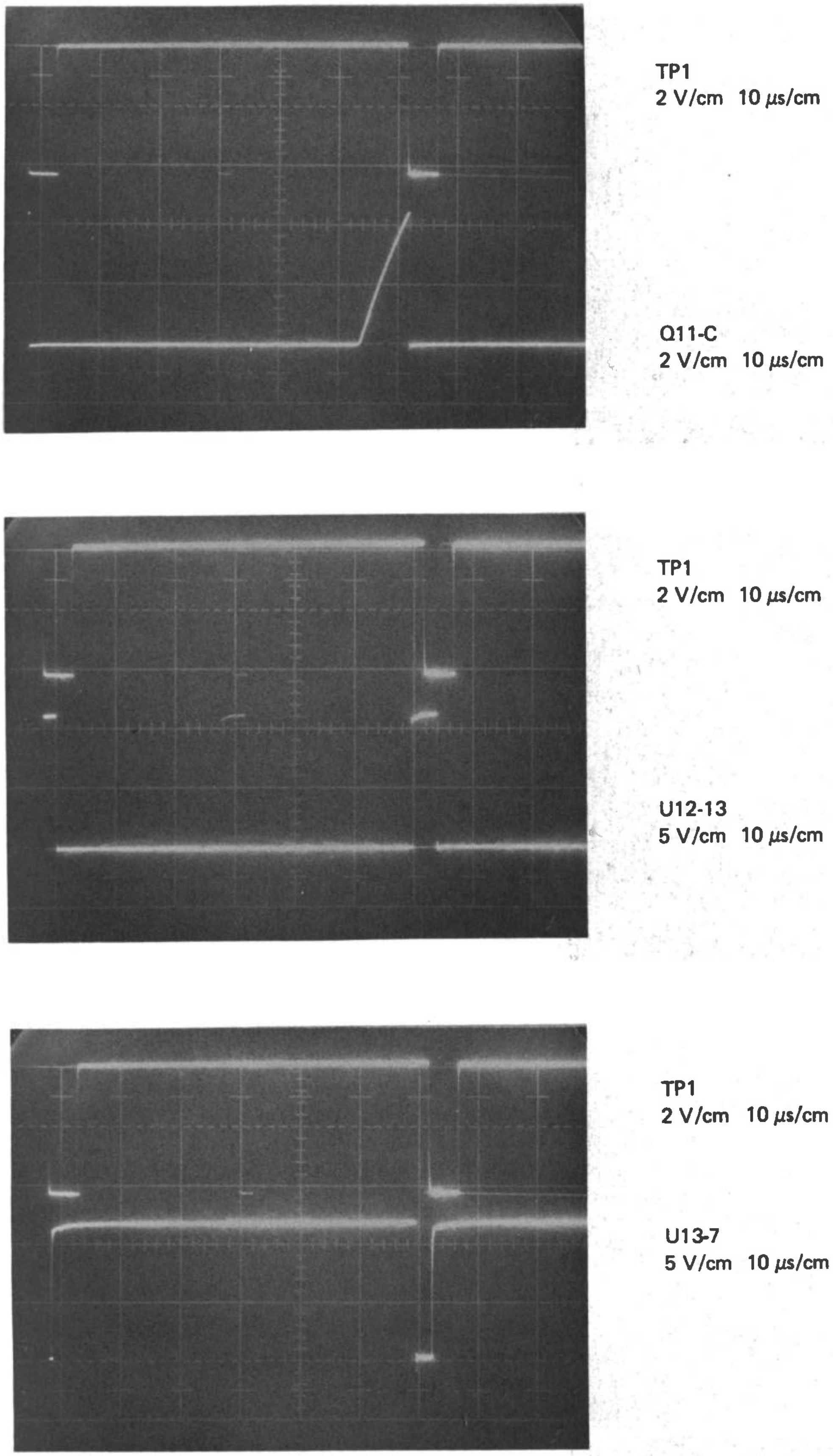


Q31-C
0.5 V/cm 2 ms/cm

V Trigger In
10 V/cm 2 ms/cm

V Saw full cw all others nulled

Figure 12-10. Waveforms, Shading Generator Board (A502)
(Sheet 2 of 2)



TP1
2 V/cm 10 μs/cm

Q11-C
2 V/cm 10 μs/cm

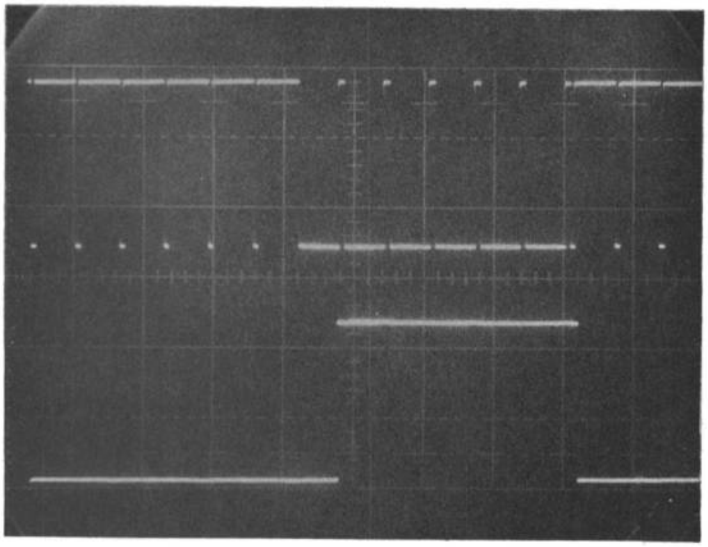
TP1
2 V/cm 10 μs/cm

U12-13
5 V/cm 10 μs/cm

TP1
2 V/cm 10 μs/cm

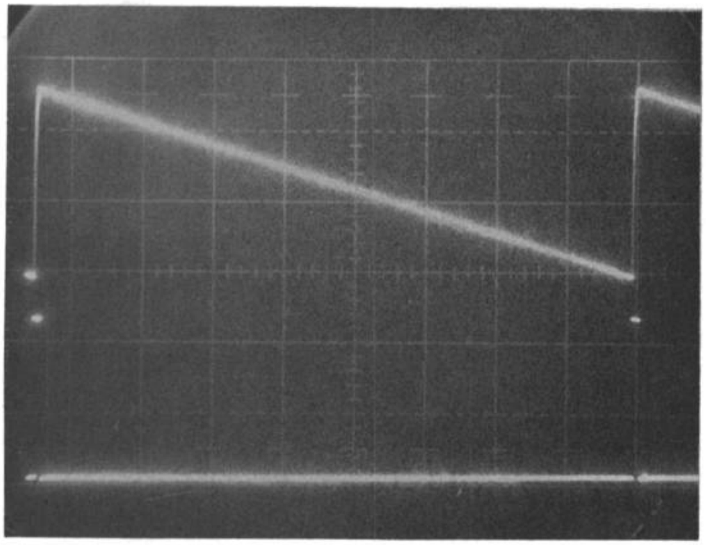
U13-7
5 V/cm 10 μs/cm

Figure 12-11. Waveforms, Deflection Board (A503)
(Sheet 1 of 4)



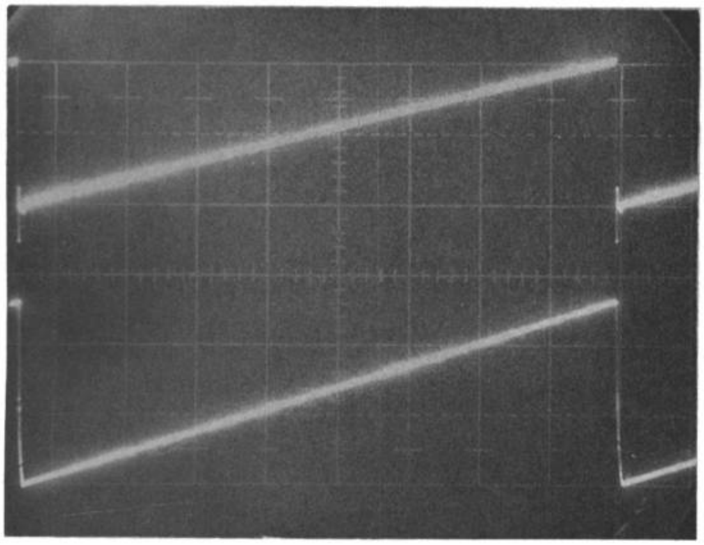
TP1
2 V/cm 50 µs/cm

TP41
5 V/cm 50 µs/cm



TP61
2 V/cm 2 ms/cm

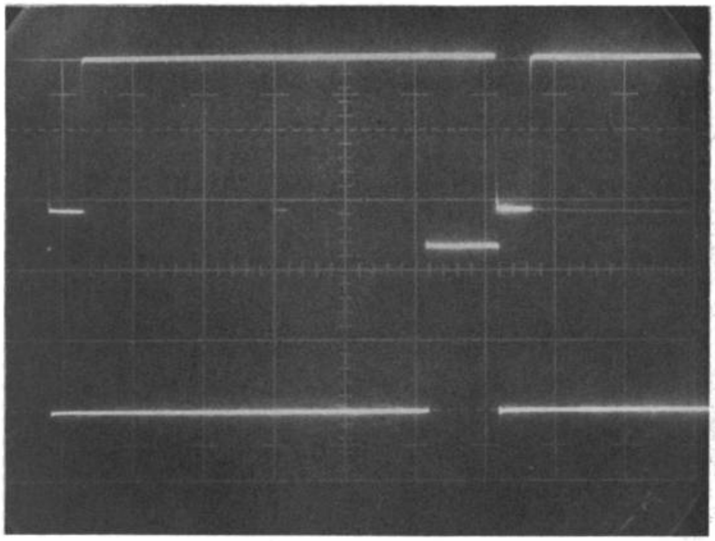
TP41
5 V/cm 2 ms/cm

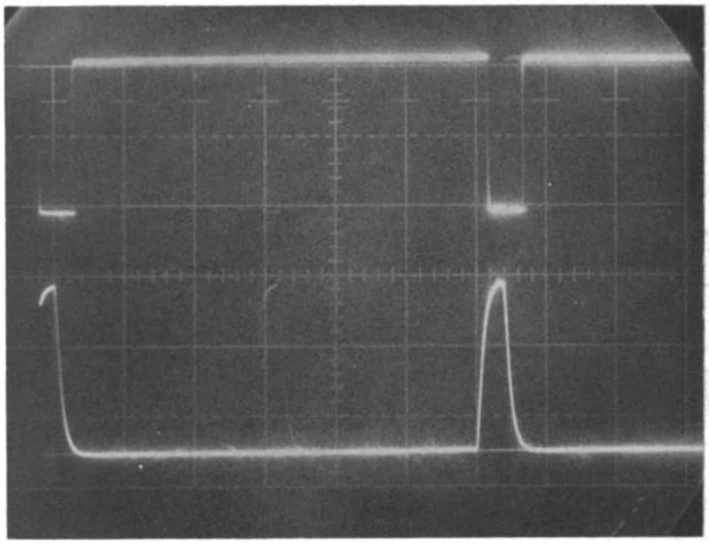


TP63
5 V/cm 2 ms/cm

TP62
2 V/cm 2 ms/cm

Figure 12-11. Waveforms, Deflection Board (A503)
(Sheet 2 of 4)





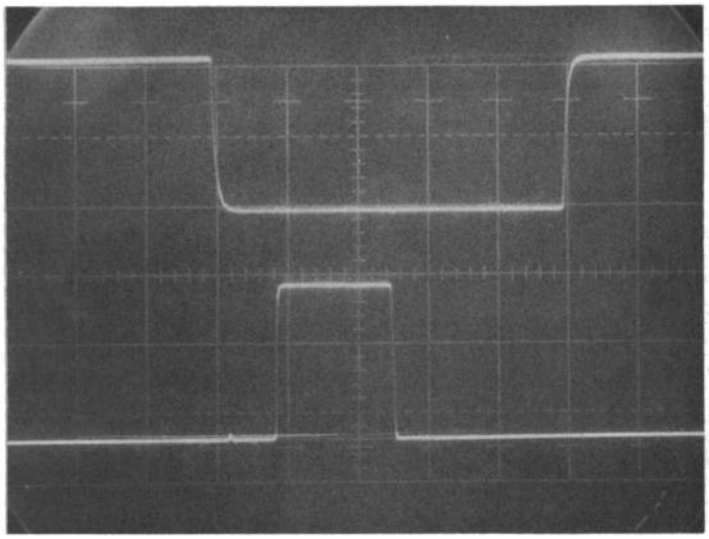
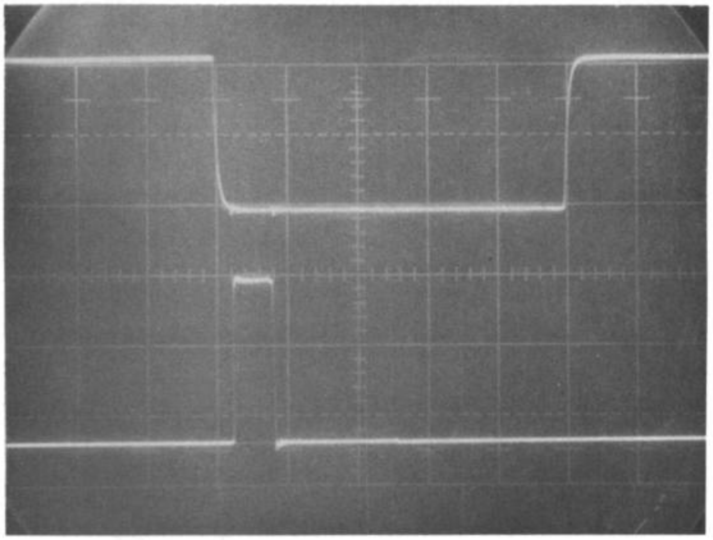


Figure 12-11. Waveforms, Deflection Board (A503)
(Sheet 3 of 4)



TP1
2 V/cm 1 μs/cm

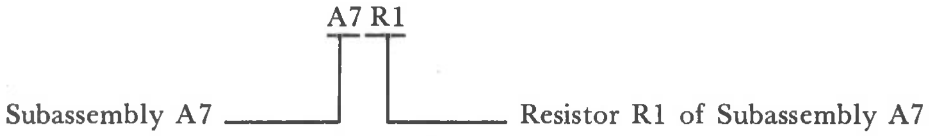
U31-5
5 V/cm 1 μs/cm

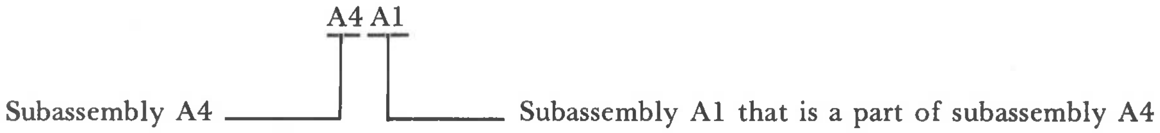
Figure 12-11. Waveforms, Deflection Board (A503)
(Sheet 4 of 4)

PART TWO – CCU

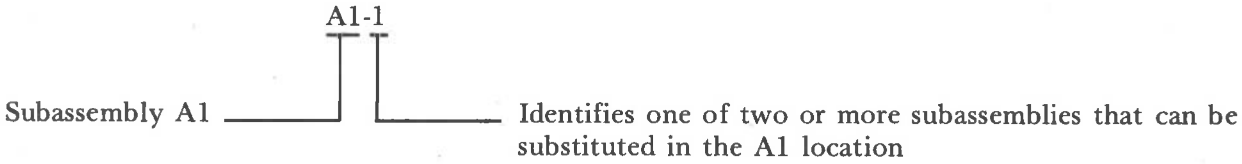
SECTION VI
PARTS LISTS

This section contains parts listings for the unit described in the manual. The first parts list identifies items related to the main chassis. Subsequent parts lists are for the subassemblies contained therein. They appear in reference-designation order. This system of identification places assemblies and components in order by alphabetical and numerical designations. For example:





If more than one type of assembly can be installed in a position, numbers are added to the end of their reference designations to distinguish them. For example:


A1-1
Subassembly A1
Identifies one of two or more subassemblies that can be substituted in the A1 location

Unused reference designations are not listed; thus, notations such as Not Used do not appear in a parts list sequence where reference designations are skipped.

Included in the lists are electrical components–resistors, transistors, ICs, and the like–together with closely associated parts such as connectors, IC sockets, and fuses. Mechanical parts subjected to wear, damage, or loss in normal use appear in the lists, too.

Illustrations are placed with the parts lists as an aid in identifying component locations and other features.

All parts are identified by name and description together with a Cohu part number. Transistors, diodes, ICs, and similar parts may also be identified by the name and part number of a particular manufacturer. Equivalent parts from other manufacturers may be substituted; however, if the designation "only" appears together with the manufacturer and part-number reference, no substitution should be made. Only the exact part from that manufacturer is acceptable. In all cases, though, the Cohu part number can be used to order the part from either the factory or an authorized representative.

Table 13-1. 8000 Series Camera Control Unit Parts List

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 2 Type 8460090-001 CCU	
A501	Video Board	8460601-001
A502	Shading Board (Option)	8460701-001
A503	Deflection Board	8460401-001
A504-1	Sync Generator Board (Option)	8460811-001
A504-2	Blanking Board (Option)	8462001-001
A505	Extender Card	8462205-001
A506	Power Supply Assembly	8460502-001
A507	Interconnection Board	8461921-001
J31	Receptacle, Square Flange	1310306-001
	Contacts	1310308-101
J32	Connector, Insulated, BNC	1310242-001
J33	Same as J32	
J34	Connector, BNC	1310242-001
J35	Same as J34	
J36	Same as J34	
J37	Same as J34	
MP1	Filler Panel	
MP2	Foot (Portable Unit Only)	2010157-005
MP3	Handle (Portable Unit Only)	2010617-001
P1B	Connector, 10 Contact	1310327-010
P2B	Connector, 6 Contact	1310327-006
P3B	Same as P1B	
P6B	Connector, Double Row, 16 Contact	1310328-016
	Contacts for P1B, P2B, P3B, P6B	1310327-102
	Key for P1B, P2B, P3B, P6B	1310327-151

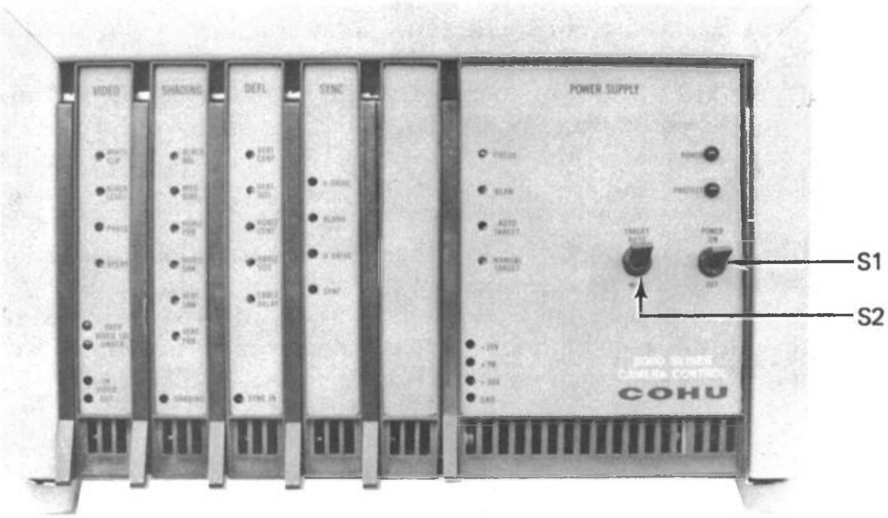


Figure 13-1. Model 8000 CCU, Front View, Location of Components

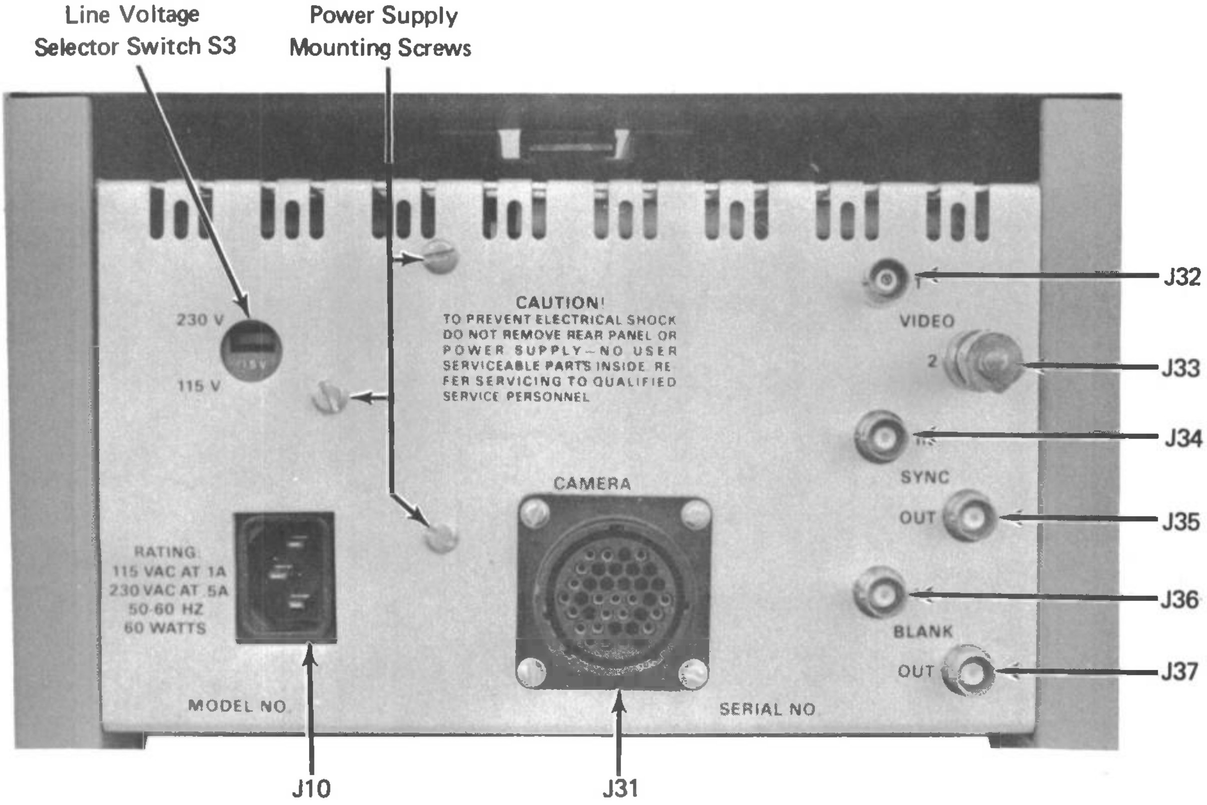


Figure 13-2. Model 8000 CCU, Rear View, Location of Components

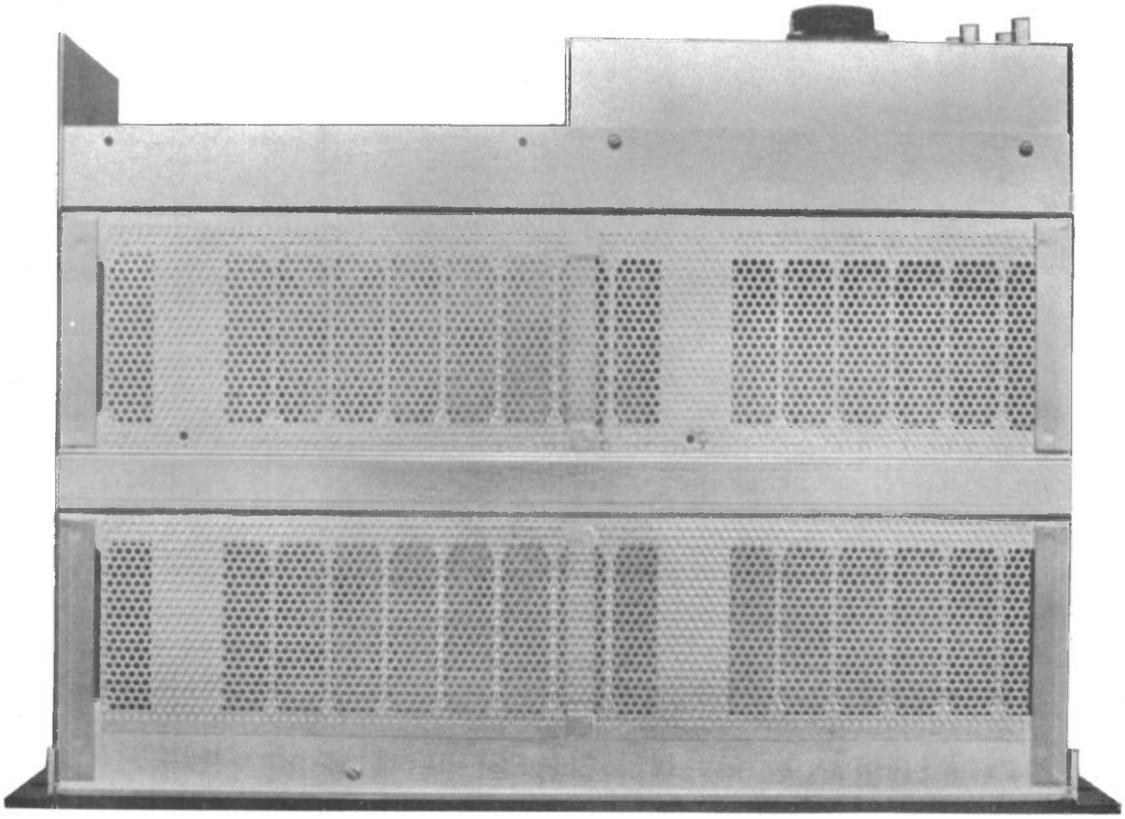


Figure 13-3. Model 8000 CCU, Top View, Location of Components

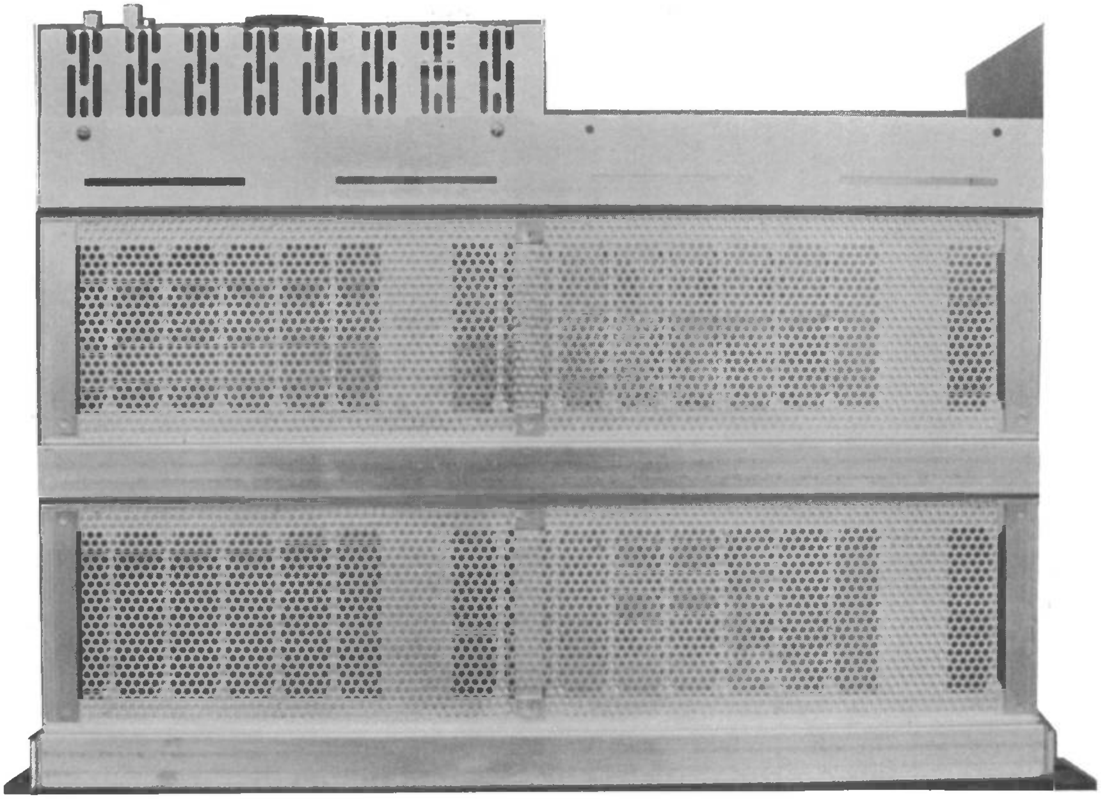


Figure 13-4. Model 8000 CCU, Bottom View, Location of Components

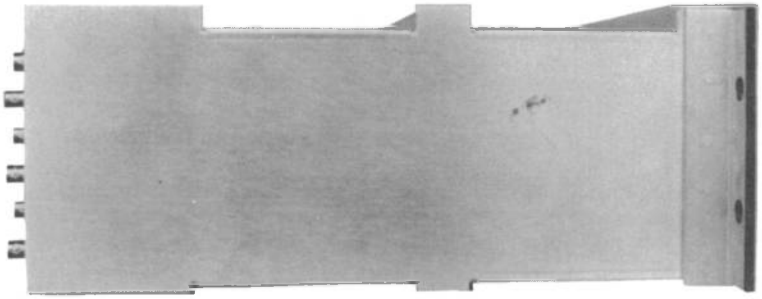


Figure 13-5. Model 8000 CCU, Right View, Location of Components

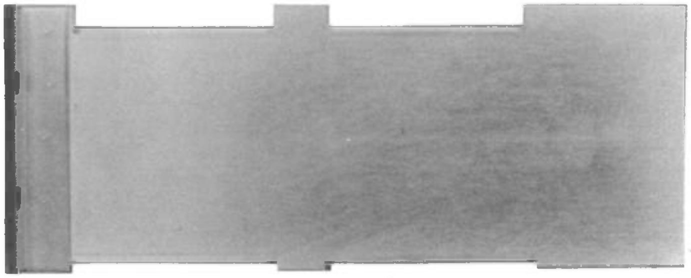


Figure 13-6. Model 8000 CCU, Left View, Location of Components

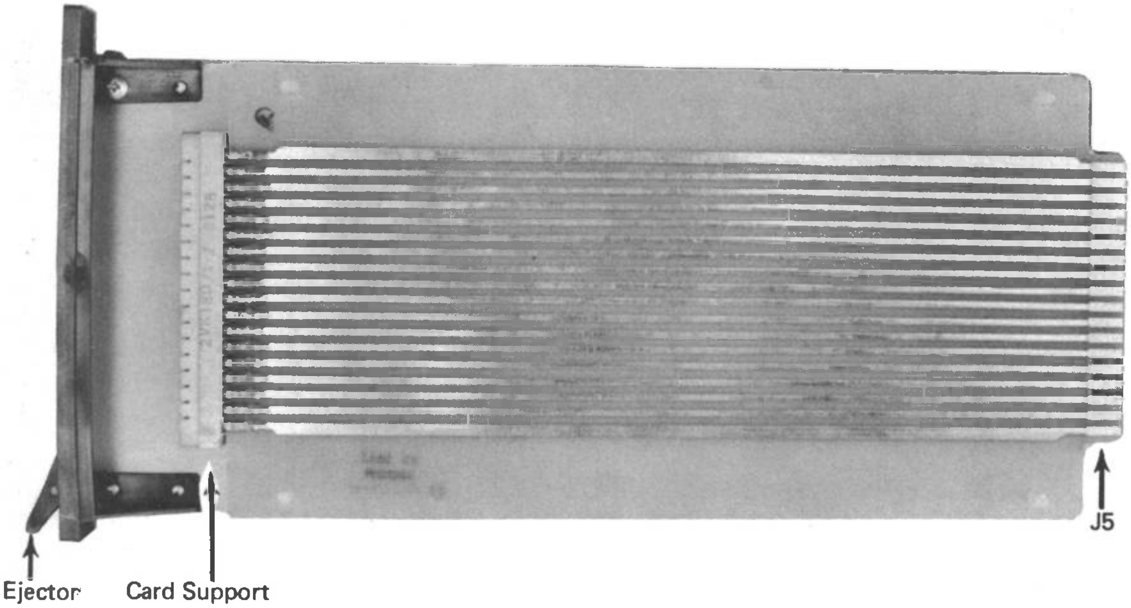


Figure 13-7. Type 8462205-001 Extender Board (A505), Location of Components

Table 13-2. Type 8460601-001 Video Board (A501) Parts List

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 3	
A1	Filter Board, 8 MHz	8460611-008
	Filter Board, 12 MHz	8460611-012
	Filter Board, 16 MHz	8460611-016
	Filter Board, 20 MHz	8460611-020
	Filter Board, 32 MHz	8460611-032

A1 FILTER BOARD	L11	C11	WHERE USED
8460611-032	1.32-1.65	68 pF	32 MHz
8460611-020			*20 MHz
8460611-016	5.02-6.2	130 pF	16 MHz
8460611-012			*12 MHz
8460611-008	13.9-15.8	270 pF	8 MHz

*Available in future.

CABLE COMPENSATION			
CABLE	C4	R3	MAX BW
100 ft.	*	*	32 MHz
500 ft.	15 pF	470	32 MHz
1000 ft.	33 pF	Jumper	16 MHz
1500 ft.	47 pF	Jumper	8 MHz
2000 ft.	68 pF	Jumper	8 MHz

*Leave component out of circuit.

REF DES	DESCRIPTION	COHU PART NUMBER
C4	Capacitor, Silver Mica, 15 pF, ±5%, 500 V	1010006-150
	Capacitor, Silver Mica, 33 pF, ±5%, 500 V	1010006-330
	Capacitor, Silver Mica, 47 pF, ±5%, 500 V	1010006-470
	Capacitor, Silver Mica, 68 pF, ±5%, 500 V	1010006-680
C5	Capacitor, Ceramic Disk, 0.05 µF, -20 +80%, 20 V	0410036-003
C6	Same as C5	
C11	Capacitor, Silver Mica, 68 pF, ±5%, 500 V	1010006-680
	Capacitor, Silver Mica, 130 pF, ±5%, 500 V	1010006-131
	Capacitor, Silver Mica, 270 pF, ±5%, 500 V	1010006-271
C12	Capacitor, Ceramic Disk, 470 pF, ±20%, 1 kV	0401038
C13	Capacitor, Electrolytic, 47 µF, -10 +150%, 16 V	0510166-476
C14	Same as C5	
C15	Capacitor, Silver Mica, 120 pF, ±5%, 500 V	1010006-121
C16	Same as C12	
C17	Capacitor, Electrolytic, 22 µF, -10 +150%	0510166-226
C18	Capacitor, Ceramic Disk, 200 pF, ±20%, 1 kV	0401028
C30	Capacitor, Ceramic Disk, 0.1 µF, -20 +80%, 20 V	0410036-002
C31	Capacitor, Film, 0.22 µF, ±20%, 100 V	0610157-224
C32	Same as C5	
C33	Capacitor, Film, 1 µF, ±20%, 100 V	0610136-105
C34	Capacitor, Tantalum, 1 µF, ±20%, 35 V	0510155-005
C37	Same as C5	
C38	Capacitor, Silver Mica, 56 pF, ±5%, 500 V	1010006-560
C39	Same as C5	
C40	Same as C17	
C61	Same as C17	

Table 13-2. Type 8460601-001 Video Board (A501) Parts List (Cont'd)

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 3	
C62	Same as C5	
C63	Capacitor, Silver Mica, 2 pF, ±0.5 pF, 300 V	1010005-020
C64	Same as C5	
C65	Capacitor, Ceramic Disk, 0.01 μF, ±35%, 50 V	0410009-103
C82	Same as C5	
C83	Capacitor, Tantalum, 2.2 μF, ±20%, 25 V	0510155-002
C100	Capacitor, Variable, 2.3–20 pF, 500 V	0910014-001
C101	Capacitor, Silver Mica, 2 pF, ±0.5 pF, 500 V	1010006-020
C102	Capacitor, Silver Mica, 47 pF, ±5%, 500 V	1010006-470
C103	Not Used	
C120	Same as C5	
C121	Capacitor, Silver Mica, 12 pF, ±5%, 500 V	1010006-120
C122	Same as C5	
C123	Same as C17	
C124	Same as C63	
C125	Same as C17	
C126	Capacitor, Tantalum, 1 μF, ±10%, 35 V	0510165-001
C140	Same as C5	
C141	Same as C5	
C142	Capacitor, Ceramic Disk, 10 pF, ±20%, 1 kV	0401004
C143	Capacitor, Film, 0.1 μF, ±20%, 100 V	0610157-104
C161	Same as C17	
C162	Capacitor, Electrolytic, 100 μF, -10 +150%, 25 V	0510166-107
C163	Capacitor, Electrolytic, 220 μF, -10 +150%, 25 V	0510166-227
CR1	Diode, Zener, 6.8 V, ±10%, SZ6.8 (Schauer Mfg.)	3510049-021
CR2	Same as CR1	
CR81	Diode, 1N4148	3510042-029
CR140	Same as CR81	
CR151	Diode, LED, PCH125-R (Data Display Products)	1710339-001
CR152	Same as CR151	
K100	Not Used	
L11	Inductor, Variable, 1.32–1.65 μH	2310056-021
	Inductor, Variable, 5.02–6.2 μH	2310056-011
	Inductor, Variable, 1.39–15.8 μH	2310056-007
MP1	Ejector, Plastic	2010643-001
Q11	Transistor, 2N4124	7210072-002
Q12	Same as Q11	
Q13	Transistor, 2N4126	7210072-003
Q14	Same as Q13	
Q15	Same as Q13	

Table 13-2. Type 8460601-001 Video Board (A501) Parts List (Cont'd)

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 3	
Q31	Same as Q11	
Q32	Same as Q13	
Q33	Transistor, FET, VCR3P (Siliconix)	7210105-001
Q101	Same as Q11	
Q102	Same as Q11	
Q121	Same as Q11	
Q122	Same as Q11	
Q123	Same as Q11	
Q124	Same as Q13	
R1	Resistor, Carbon Film, 1000 Ohm, ±5%, ¼ W	4010025-102
R2	Resistor, Carbon Film, 82 Ohm, ±5%, ¼ W	4010025-820
R3	Resistor, Carbon Film, 470 Ohm, ±5%, ¼ W	4010025-471
R4	Resistor, Carbon Film, 1300 Ohm, ±5%, ¼ W	4010025-132
R5	Resistor, Carbon Film, 180 Ohm, ±5%, ¼ W	4010025-181
R6	Resistor, Variable, 500 Ohm, ±20%, 1/5 W	5010147-501
R7	Resistor, Composition, 430 Ohm, ±5%, ¼ W	0310030-431
R8	Resistor, Carbon Film, 100 Ohm, ±5%, ¼ W	4010025-101
R11	Resistor, Carbon Film, 200 Ohm, ±5%, ¼ W	4010025-201
R12	Resistor, Variable, 250 Ohm, ±20%, 1/5 W	5010163-251
R13	Resistor, Carbon Film, 22 Ohm, ±5%m ¼ W	4010025-220
R14	Resistor, Variable, 500 Ohm, ±20%, 1/5 W	5010163-501
R15	Resistor, Carbon Film, 100 Kilohm, ±5%, ¼ W	4010025-104
R16	Resistor, Composition, 180 Ohm, ±5%, ¼ W	0310030-181
R17	Resistor, Carbon Film, 560 Ohm, ±5%, ¼ W	4010025-561
R18	Resistor, Carbon Film, 220 Ohm, ±5%, ¼ W	4010025-221
R19	Same as R1	
R20	Resistor, Carbon Film, 12 Kilohm, ±5%, ¼ W	4010025-123
R21	Resistor, Carbon Film, 56 Kilohm, ±5%, ¼ W	4010025-563
R22	Same as R18	
R23	Resistor, Carbon Film, 330 Ohm, ±5%, ¼ W	4010025-331
R24	Same as R18	
R25	Resistor, Variable, 10 Kilohm, ±20%, 1/5 W	5010147-103
R26	Same as R21	
R27	Same as R20	
R28	Same as R1	
R31	Resistor, Carbon Film, 4700 Ohm, ±5%, ¼ W	4010025-472
R32	Resistor, Carbon Film, 10 Kilohm, ±5%, ¼ W	4010025-103
R33	Resistor, Carbon Film, 470 Kilohm, ±5%, ¼ W	4010025-474
R34	Resistor, Carbon Film, 47 Ohm, ±5%, ¼ W	4010025-470
R35	Resistor, Carbon Film, 3000 Ohm, ±5%, ¼ W	4010025-302
R36	Same as R31	
R37	Resistor, Carbon Film, 22 Kilohm, ±5%, ¼ W	4010025-223
R38	Same as R1	

Table 13-2. Type 8460601-001 Video Board (A501) Parts List (Cont'd)

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 3	
R39	Same as R18	
R40	Same as R8	
R41	Resistor, Carbon Film, 6800 Ohm, ±5%, ¼ W	4010025-682
R42	Resistor, Carbon Film, 5600 Ohm, ±5%, ¼ W	4010025-562
R43	Same as R32	
R44	Resistor, Carbon Film, 470 Ohm, ±5%, ¼ W	4010025-471
R45	Resistor, Carbon Film, 820 Ohm, ±5%, ¼ W	4010025-821
R46	Resistor, Carbon Film, 3300 Ohm, ±5%, ¼ W	4010025-332
R47	Same as R17	
R48	Same as R31	
R49	Resistor, Carbon Film, 1500 Ohm, ±5%, ¼ W	4010025-152
R50	Same as R20	
R51	Resistor, Variable, 10 Kilohm, ±20%, 1/5 W	5010163-103
R52	Same as R1	
R60	Same as R34	
R61	Same as R46	
R62	Same as R41	
R63	Same as R1	
R64	Same as R1	
R65	Same as R6	
R66	Same as R4	
R67	Same as R31	
R68	Resistor, Carbon Film, 150 Ohm, ±5%, ¼ W	4010025-151
R69	Resistor, Carbon Film, 510 Ohm, ±5%, ¼ W	4010025-511
R70	Resistor, Carbon Film, 910 Ohm, ±5%, ¼ W	4010025-911
R71	Same as R34	
R72	Resistor, Carbon Film, 33 Kilohm, ±5%, ¼ W	4010025-333
R73	Resistor, Carbon Film, 18 Kilohm, ±5%, ¼ W	4010025-183
R74	Resistor, Variable 1000 Ohm, ±20%, 1/5 W	5010147-102
R75	Same as R34	
R76	Same as R31	
R77	Same as R32	
R78	Resistor, Carbon Film, 15 Kilohm, ±5%, ¼ W	4010025-153
R81	Same as R20	
R82	Resistor, Carbon Film, 220 Kilohm, ±5%, ¼ W	4010025-224
R83	Resistor, Carbon Film, 68 Kilohm, ±5%, ¼ W	4010025-683
R84	Resistor, Carbon Film, 2400 Ohm, ±5%, ¼ W	4010025-242
R86	Same as R15	
R87	Same as R1	
R88	Resistor, Composition, 2.7 Megohm, ±5%, ¼ W	4045000-275
R89	Resistor, Carbon Film, 1 Megohm, ±5%, ¼ W	4010024-105
R90	Same as R51	

Table 13-2. Type 8460601-001 Video Board (A501) Parts List (Cont'd)

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 3	
R91	Same as R32	
R92	Same as R32	
R93	Same as R8	
R101	Resistor, Carbon Film, 1600 Ohm, ±5%, ¼ W	4010025-162
R102	Resistor, Carbon Film, 20 Kilohm, ±5%, ¼ W	4010025-203
R103	Same as R6	
R104	Same as R84	
R105	Same as R31	
R106	Same as R46	
R107	Same as R82	
R108	Same as R31	
R109	Resistor, Carbon Film, 36 Kilohm, ±5%, ¼ W	4010025-363
R110	Resistor, Variable, 50 Kilohm, ±20%, 1/5 W	5010147-503
R111	Same as R32	
R112	Same as R31	
R113	Same as R31	
R114	Resistor, Carbon Film, 10 Kilohm, ±5%, ¼ W	4010025-103
R115	Same as R31	
R116	Same as R84	
R117	Resistor, Carbon Film, 750 Ohm, ±5%, ¼ W	4010025-751
R121	Resistor, Carbon Film, 43 Ohm, ±5%, ¼ W	4010025-430
R122	Resistor, Carbon Film, 27 Ohm, ±5%, ¼ W	4010025-270
R123	Same as R70	
R124	Same as R44	
R125	Resistor, Carbon Film, 75 Ohm, ±5%, ¼ W	4010025-750
R126	Same as R125	
R127	Same as R45	
R128	Same as R44	
R129	Same as R1	
R130	Same as R44	
R131	Same as R25	
R132	Same as R37	
R133	Same as R31	
R140	Same as R44	
R141	Same as R73	
R142	Resistor, Carbon Film, 1800 Ohm, ±5%, ¼ W	4010025-182
R143	Same as R114	
R144	Same as R89	
R145	Same as R37	
R146	Same as R37	
R151	Resistor, Variable, 20 Kilohm, ±20%, 1/5 W	5010147-203
R152	Same as R20	

Table 13-2. Type 8460601-001 Video Board (A501) Parts List (Cont'd)

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 3	
R153	Same as R4	
R154	Resistor, Carbon Film, 3900 Ohm, ±5%, ¼ W	4010025-392
R155	Same as R49	
R156	Same as R49	
TP1	Test point	1710250-004
TP11	Test point	1710280-001
TP31	Same as TP11	
TP61	Same as TP11	
TP101	Same as TP11	
TP121	Same as TP1	
GND	Same as TP11	
U1	Amplifier, Video, LM733CN (Signetics)	3610078-001
U31	Transistor Array, CA3083 (RCA)	3610192-001
U61	Same as U31	
U62	Same as U31	
U81	Operational Amplifier, LM318N (National)	3610220-001
U101	Same as U31	
U120	Operational Amplifier, NE5539N (Signetics)	3610273-001
U140	Same as U81	
U141	Amplifier, Dual Operational, SN72558P (Signetics)	3610132-001
U150	Same as U41	
U161	Regulator, 8 V, LM340T-08 (National)	3610144-008
XU1	Socket, Integrated Circuit, 14 pin	1710292-007
XU31	Socket, Integrated Circuit, 16 pin	1710292-008
XU61	Same as XU31	
XU62	Same as XU31	
XU81	Socket, Integrated Circuit, 8 pin	1710292-004
XU101	Same as XU31	
XU120	Same as XU1	
XU140	Same as XU81	
XU141	Same as XU81	
XU150	Same as XU81	

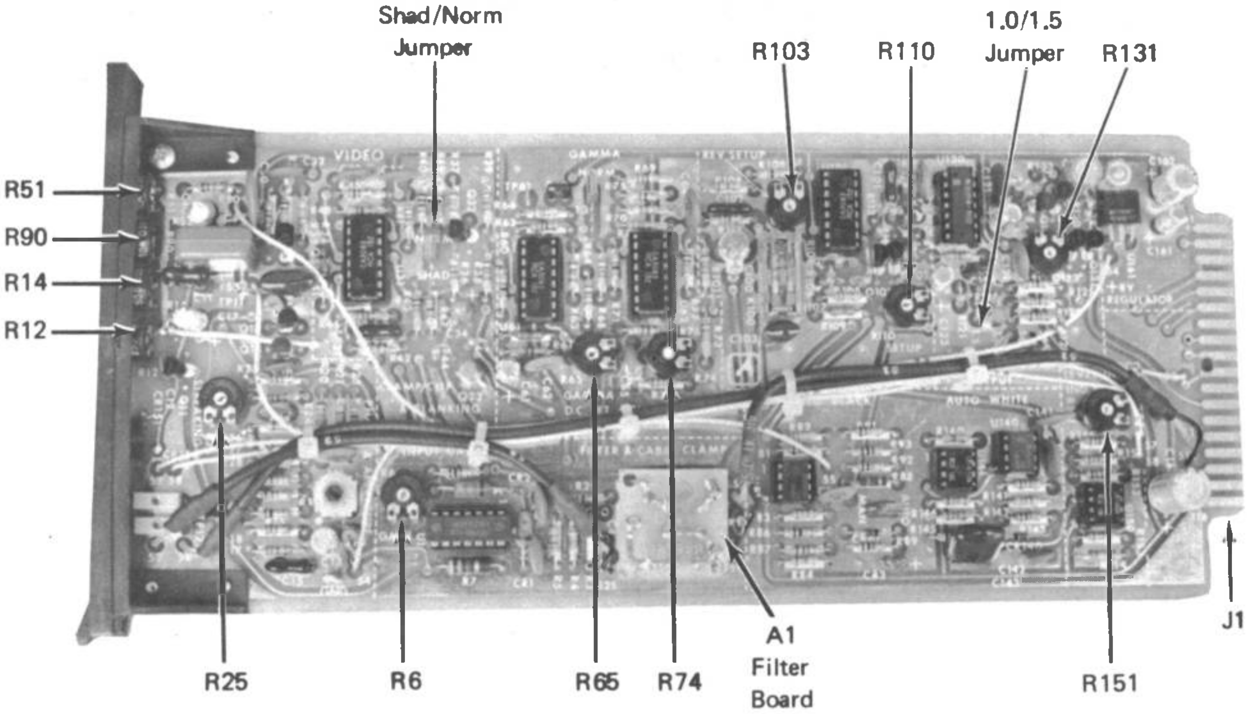


Figure 13-8. Type 8460601-001 Video Board (A501), Location of Components

Table 13-3. Type 8460611-008/ -012/ -016/ -020/ -032 Filter Board (A501A1) Parts List

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 2	
C1	Capacitor, Silver Mica, ±5%, 500 V	
C2	Capacitor, Silver Mica, ±5%, 500 V	
C3	Same as C1	
L1	Inductor	
L2	Same as L1	

	-008	-012	-016	-020	-032
	8 MHz	12 MHz	16 MHz	20 MHz	32 MHz
C1	200 pF 1010006-201	120 pF 1010006-121	100 pF 1010006-101	75 pF 1010006-750	47 pF 1010006-470
C2	390 pF 1010006-391	270 pF 1010006-271	200 pF 1010006-201	160 pF 1010006-161	100 pF 101006-101
C3	Same as C1	Same as C1	Same as C1	Same as C1	Same as C1
L1	2.20 µH 2310067-012	1.50 µH 2310067-010	1.20 µH 2310067-009	0.82 µH 2310067-007	0.56 µH 2310067-005
L2	Same as L1	Same as L1	Same as L1	Same as L1	Same as L1

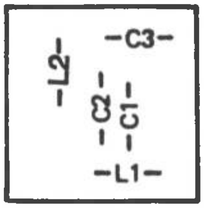


Figure 13-9. Type 8460611-008/ -012/ -016/ -020/ -032 Filter Board (A501A1), Location of Components

Table 13-4. Type 8460701-001 Shading Board (A502) Parts List

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 3	
C3	Capacitor, Silver Mica, 3300 pF, ±5%, 500 V	1010007-332
C4	Capacitor, Film, 0.22 μF, ±10%, 100 V	0610157-224
C5	Same as C3	
C31	Capacitor, Silver Mica, 27 pF, ±10%, 300 V	1010006-270
C32	Capacitor, Electrolytic, 10 μF, -20 +75%, 50 V	0510166-106
C33	Capacitor, Ceramic Disk, 0.1 μF, -20 +80%, 20 V	0410036-002
C34	Same as C33	
C81	Capacitor, Film Dielectric, 0.022 μF, ±10%, 100 V	0610157-223
C82	Capacitor, Film, 1 μF, ±20%, 100 V	0610136-105
C83	Capacitor, Electrolytic, 47 μF, -20 +75%, 16 V	0510166-476
C84	Same as C82	
C111	Capacitor, Electrolytic, 22 μF, -20 +75%, 25 V	0510166-226
C112	Same as C83	
C113	Same as C83	
MP1	Ejector, Plastic	2010643-001
Q2	Transistor, 2N4124	7210072-002
Q31	Transistor, 2N4126	7210072-003
Q81	Same as Q2	
Q82	Same as Q31	
R1	Resistor, Carbon Film, 22 Kilohm, ±5%, ¼ W	4010025-223
R3	Resistor, Carbon Film, 6800 Ohm, ±5%, ¼ W	4010025-682
R4	Resistor, Carbon Film, 27 Kilohm, ±5%, ¼ W	4010025-273
R5	Same as R1	
R6	Resistor, Variable, 10 Kilohm, ±20%, 1/5 W	5010163-103
R7	Resistor, Carbon Film, 2200 Ohm, ±5%, ¼ W	4010025-222
R8	Resistor, Carbon Film, 8200 Ohm, ±5%, ¼ W	4010025-822
R9	Resistor, Carbon Film, 47 Kilohm, ±5%, ¼ W	4010025-473
R10	Same as R6	
R11	Not Used	
R31	Same as R9	
R32	Same as R9	
R33	Same as R9	
R34	Same as R9	
R35	Same as R9	
R36	Resistor, Carbon Film, 2700 Ohm, ±5%, ¼ W	4010025-272
R37	Resistor, Carbon Film, 33 Kilohm, ±5%, ¼ W	4010025-333
R38	Same as R36	
R39	Resistor, Carbon Film, 15 Kilohm, ±5%, ¼ W	4010025-153
R40	Resistor, Carbon Film, 1000 Ohm, ±5%, ¼ W	4010025-102
R41	Resistor, Variable, 5 Kilohm, ±20%, 1/5 W	5010163-502
R42	Same as R9	
R43	Resistor, Carbon Film, 470 Ohm, ±5%, ¼ W	4010025-471

Table 13-4. Type 8460701-001 Shading Board (A502) Parts List (Cont'd)

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 3	
R44	Same as R38	
R45	Same as R40	
R46	Resistor, Variable, 50 Kilohm, ±20%, 1/5 W	5010163-503
R47	Same as R9	
R48	Same as R8	
R49	Same as R9	
R50	Same as R9	
R81	Same as R38	
R82	Same as R38	
R83	Resistor, Carbon Film, 10 Kilohm, ±5%, ¼ W	4010025-103
R84	Same as R37	
R85	Same as R37	
R86	Same as R6	
R87	Same as R7	
R89	Same as R9	
R90	Same as R6	
R91	Resistor, Carbon Film, 3300 Ohm, ±5%, ¼ W	4010025-332
TP31	Terminal, Test Point	1710280-001
TP32	Same as TP31	
TP33	Connector, Test Point	1710250-004
TP81	Same as TP31	
TP82	Same as TP31	
U1	Dual Operational Amplifier, SN72558P (Motorola)	3610132-003
U31	Same as U1	
U81	Same as U1	
U111	Voltage Regulator, 78L12	3610195-012
XU1	Socket, Integrated Circuit, 8-Pin	1710292-004
XU31	Same as XU1	
XU81	Same as XU1	
XU111	Same as XU1	

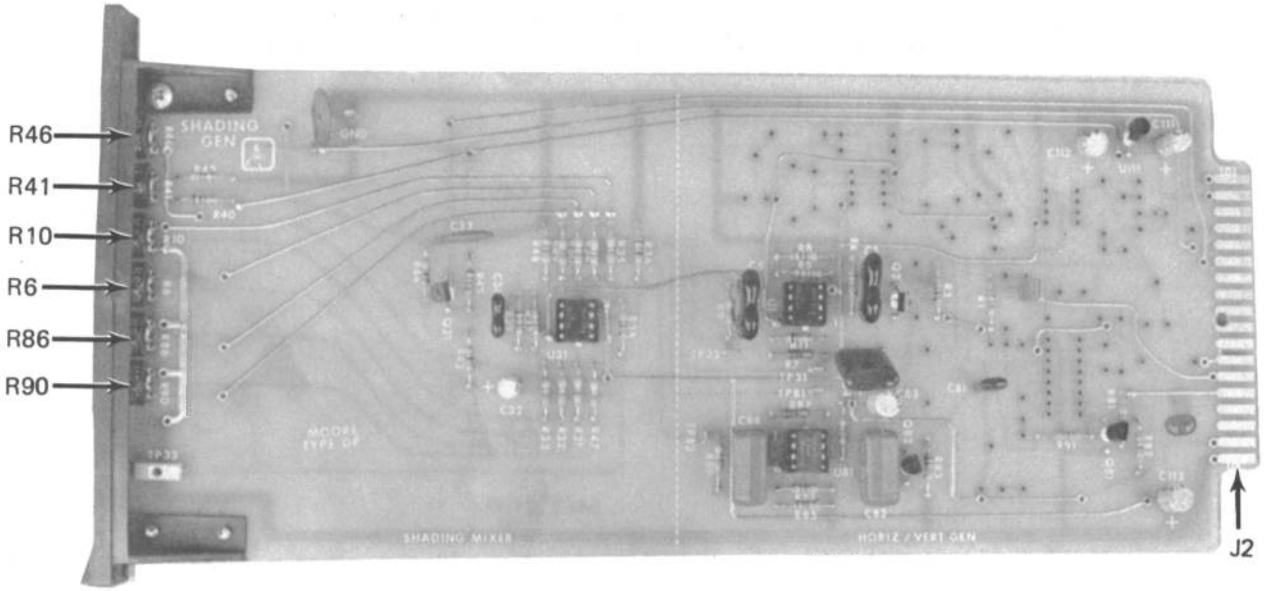


Figure 13-10. Type 8460701-001 Shading Board (A502), Location of Components

Table 13-5. Type 8460401-001 Deflection Board (A503) Parts List

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 5	
C1	Capacitor, Film, 0.047 μF, ±10%, 100 V	0610157-473
C2	Capacitor, Ceramic Disk, 0.1 μF, -20 +80%, 20 V	0410036-002
C11	Capacitor, Silver Mica, 1200 pF, ±5%, 500 V	1010007-122
C12	Capacitor, Silver Mica, 1000 pF, ±5%, 500 V	1010007-102
C13	Capacitor, Ceramic Disk, 100 pF, ±20%, 1 kV	0401022
C14	Capacitor, Film, 0.1 μF, ±10%, 100 V	0610157-104
C15	Capacitor, Ceramic Disk, 220 pF, ±20%, 1 kV	0401028
C16	Capacitor, Film, 0.01 μF, ±10%, 100 V	0610157-103
C17	Capacitor, Silver Mica, 220 pF, ±5%, 500 V	1010006-221
C18	Same as C2	
C31	Capacitor, Silver Mica, 68 pF, ±5%, 500 V	1010006-680
C32	Capacitor, Ceramic Disk, 68 pF, ±20%, 1 kV	0401018
C41	Capacitor, Film, 0.0001 μF, ±10%, 100 V	0610157-102
C42	Same as C41	
C61	Capacitor, Film, 0.47 μF, ±20%, 100 V	0610136-474
C62	Same as C2	
C63	Same as C2	
C64	Same as C16	
C65	Capacitor, Film, 0.022 μF, ±10%, 100 V	0610157-223
C81	Capacitor, Electrolytic, 47 μF, -20 +75%, 16 V	0510166-476
C82	Capacitor, Electrolytic, 100 μF, -20 +75%, 25 V	0510166-107
C83	Same as C81	
CR1	Diode, 1N4148	3510042-029
MP1	Ejector, Plastic	2010643-001
Q1	Transistor, 2N4124	7210072-002
Q11	Same as Q1	
Q12	Same as Q1	
Q61	Transistor, 2N4126	7210072-003
R2	Resistor, Carbon Film, 10 Kilohm, ±5%, ¼ W	4010025-103
R3	Resistor, Carbon Film, 75 Ohm, ±5%, ¼ W	4010025-750
R11	Resistor, Variable, 50 Kilohm, ±20%, 1/5 W	5010147-503
R12	Resistor, Carbon Film, 12 Kilohm, ±5%, ¼ W	4010025-123
R13	Resistor, Carbon Film, 4700 Ohm, ±5%, ¼ W	4010025-472
R14	Resistor, Carbon Film, 18 Kilohm, ±5%, ¼ W	4010025-183
R15	Resistor, Carbon Film, 22 Kilohm, ±5%, ¼ W	4010025-223
R16	Resistor, Variable, 10 Kilohm, ±20%, 1/5 W	5010163-103
R17	Resistor, Carbon Film, 2200 Ohm, ±5%, ¼ W	4010025-222
R18	Same as R17	
R19	Resistor, Carbon Film, 1000 Ohm, ±5%, ¼ W	4010025-102
R20	Same as R13	
R21	Same as R1	
R22	Resistor, Carbon Film, 47 Ohm, ±5%, ¼ W	4010025-470

Table 13-5. Type 8460401 Deflection Board (A503) Parts List (Cont'd)

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 5	
R23	Resistor, Carbon Film, 15 Kilohm, ±5%, ¼ W	4010025-153
R24	Resistor, Carbon Film, 5600 Ohm, ±5%, ¼ W	4010025-562
R25	Same as R16	
R26	Same as R24	
R27	Resistor, Carbon Film, 56 Kilohm, ±5%, ¼ W	4010025-563
R28	Same as R15	
R31	Same as R24	
R32	Same as R11	
R33	Same as R14	
R41	Resistor, Carbon Film, 30 Kilohm, ±5%, ¼ W	4010025-303
R42	Resistor, Carbon Film, 180 Kilohm, ±5%, ¼ W	4010025-184
R51	Same as R15	
R52	Same as R16	
R53	Same as R1	
R61	Same as R13	
R62	Same as R23	
R63	Resistor, Carbon Film, 120 Kilohm, ±5%, ¼ W	4010025-124
R64	Resistor, Carbon Film, 100 Ohm, ±5%, ¼ W	4010025-101
R65	Resistor, Carbon Film, 6800 Ohm, ±5%, ¼ W	4010025-682
R66	Resistor, Carbon Film, 1500 Ohm, ±5%, ¼ W	4010025-152
R67	Resistor, Variable, 50 Kilohm, ±20%, 1/5 W	5010163-503
R68	Same as R15	
R69	Resistor, Carbon Film, 3900 Ohm, ±5%, ¼ W	4010025-392
R70	Resistor, Variable, 5000 Ohm, ±20%, 1/5 W	5010163-502
R71	Resistor, Carbon Film, 68 Ohm, ±5%, ¼ W	4010025-680
R91	Same as R3	
TP1	Test point	1710250-004
TP11	Test point	1710280-001
TP12	Same as TP11	
TP31	Same as TP11	
TP41	Same as TP11	
TP61	Same as TP11	
TP62	Same as TP11	
TP63	Same as TP11	
GND	Same as TP11	
U11	Multivibrator, Schmitt Trigger Inputs, 74C221	3610214-003
U12	Timer, Low Power, ICM75551PA (Intersil)	3610277-001
U13	Voltage Comparator, LM311	3610131-002
U31	Same as U11	
U61	Operational Amplifier, SN72741P (Signetics)	3610108-001
U62	Operational Amplifier, μA759U1C (Fairchild)	3610239-001
U80	Regulator, 12 V, T8L12 (Fairchild)	3610195-012

Table 13-5. Type 8460401-001 Deflection Board (A503) Parts List (Cont'd)

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 5	
XU11	Socket, Integrated Circuit, 16 pin	1710292-008
XU12	Socket, Integrated Circuit, 8 pin	1710292-004
XU13	Same as XU12	
XU31	Same as XU11	
XU61	Same as XU12	

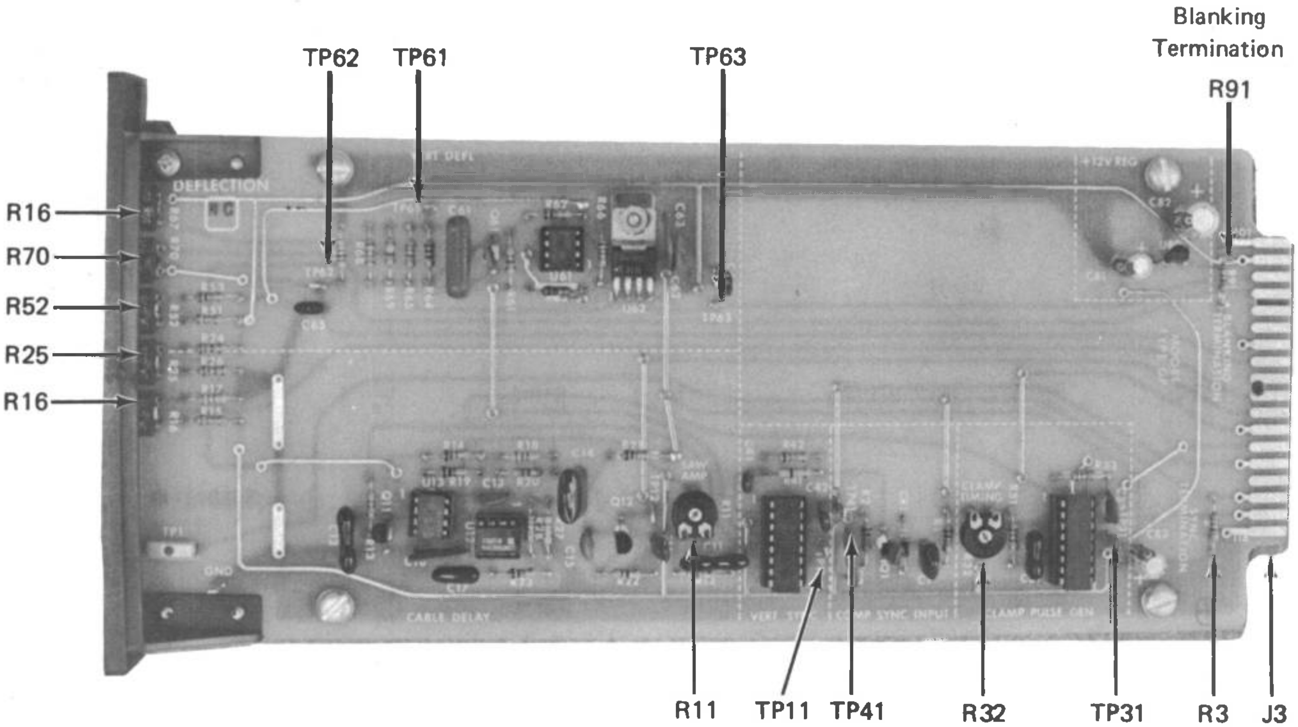


Figure 13-11. Type 8460401-001 Deflection Board (A503), Location of Components

Table 13-6. Type 8460811-001 Sync Generator Board (A504-1) Parts List

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 1	
C1	Capacitor, Ceramic Disk, 0.05 μF, -20 +80%, 20 V	0410036-003
C2	Capacitor, Ceramic Disk, 47 pF, ±5%, 500 V	0410032-470
C3	Capacitor, Tantalum, 22 μF, ±20%, 15 V	0510155-005
C4	Same as C3	
C5	Capacitor, Ceramic Disk, 0.01 μF, ±35%, 50 V	0410009-103
C7	Capacitor, Silver Mica, 33 pF, ±5%, 500 V	1010006-330
C8	Same as C1	
C9	Same as C1	
C10	Capacitor, Ceramic Disk, 15 pF, ±5%, 500 V	0410032-150
C11	Same as C1	
C12	Same as C1	
C13	Same as C5	
C14	Capacitor, Variable, 8–50 pF, 350 V	0910002-009
C15	Same as C1	
C16	Same as C1	
C21	Same as C1	
C22	Capacitor, Silver Mica, 220 pF, ±5%, 500 V	1010006-221
C31	Capacitor, Ceramic Disk, 470 pF, ±20%, 1 kV	0401038
C32	Same as C31	
C33	Same as C31	
C34	Same as C31	
C41	Same as C1	
C61	Capacitor, Film, 0.1 μF, ±20%, 100 V	0610136-104
C62	Capacitor, Film, 0.047 μF, ±20%, 100 V	0610136-473
C71	Same as C1	
C72	Capacitor, Ceramic Disk, 47 pF, ±20%, 1 kV	0401015
C81	Same as C3	
C82	Capacitor, Silver Mica, 680 pF, ±5%, 300 V	1010006-681
C101	Same as C3	
C102	Same as C82	
C121	Capacitor, Eletrolytic, 470 μF, -10 +100%, 6.3 V	0510160-033
C122	Capacitor, Electrolytic, 47 μF, -20 +75%, 16 V	0510166-476
C123	Capacitor, Ceramic Disk, 0.1 μF, -20 +80%, 10 V	0410036-001
CR1	Diode, Varactor, 22 pF at 4 Vr, MV1634 (Motorola)	3510077-003
L1	Inductor, Variable, 0.9–1.1 μH	2310056-013
L81	Inductor, 3.9 μH	2310029-014
L101	Same as L81	
L121	Inductor, 0.1 mH, ±10%	2310039-010
MP1	Ejector, Plastic	2010643-001
Q1	Transistor, Programmable, 2N6027 (General Electric)	7210106-001
Q11	Transistor, 2N4124	7210072-002
Q12	Same as Q11	

Table 13-6. Type 8460811-001 Sync Generator Board (A504-1) Parts List (Cont'd)

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 1	
Q81	Same as Q11	
Q82	Transistor, 2N3638	7210069-001
Q101	Same as Q11	
Q102	Same as Q82	
R1	Resistor, Carbon Film, 220 Ohm, ±5%, ¼ W	4010025-221
R2	Resistor, Carbon Film, 56 Kilohm, ±5%, ¼ W	4010025-563
R3	Resistor, Carbon Film, 4700 Ohm, ±5%, ¼ W	4010025-472
R4	Same as R3	
R5	Resistor, Carbon Film, 100 Kilohm, ±5%, ¼ W	4010025-104
R6	Resistor, Carbon Film, 22 Kilohm, ±5%, ¼ W	4010025-223
R7	Same as R6	
R8	Resistor, Carbon Film, 100 Ohm, ±5%, ¼ W	4010025-101
R9	Resistor, Carbon Film, 10 Kilohm, ±5%, ¼ W	4010025-103
R10	Resistor, Carbon Film, 3300 Ohm, ±5%, ¼ W	4010025-332
R11	Resistor, Carbon Film, 680 Ohm, ±5%, ¼ W	4010025-681
R12	Same as R3	
R13	Same as R11	
R14	Same as R3	
R31	Same as R4	
R61	Resistor, Carbon Film, 18 Kilohm, ±5%, ¼ W	4010025-183
R62	Same as R6	
R63	Resistor, Carbon Film, 1000 Ohm, ±5%, ¼ W	4010025-102
R81	Resistor, Carbon Film, 470 Kilohm, ±5%, ¼ W	4010025-471
R82	Same as R4	
R83	Same as R63	
R84	Same as R81	
R85	Resistor, Carbon Film, 2200 Ohm, ±5%, ¼ W	4010025-222
R86	Resistor, Carbon Film, 75 Ohm, ±5%, ¼ W	4010025-750
R87	Same as R86	
R88	Same as R86	
R89	Same as R63	
R90	Same as R63	
R101	Same as R81	
R102	Same as R3	
R103	Same as R63	
R104	Same as R81	
R105	Same as R85	
R106	Same as R86	
R107	Same as R86	
R108	Same as R86	
R109	Same as R63	
S21	Switch Package, DIP, 10 SPST Elements	6110111-010

Table 13-6. Type 8460811-001 Sync Generator Board (A504-1) Parts List (Cont'd)

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 1	
S41	Same as S21	
TP1	Test point	1710280-001
TP2	Same as TP1	
TP3	Same as TP1	
TP21	Same as TP1	
TP41	Same as TP1	
TP42	Same as TP1	
TP51	Same as TP1	
TP61	Test point, Dual Pin	1710250-004
TP81	Same as TP61	
TP91	Same as TP61	
TP101	Same as TP61	
U2	NOR Gate, SN74LS02N (Signetics)	3610129-002
U3	NAND Gate, SN74S00N (Signetics)	3610181-001
U5	Dual J-K Flip Flop, SN74LS113N (TI)	3610203-001
U21	Synchronous 4-Bit Counter, 74LS163 (TI)	3610208-001
U22	Same as U21	
U23	NAND Gate, SN74LS30N (TI)	3610210-001
U31	ROM, Programmable, 74S288N (TI)	3610209-002
U32	Multiplexer, Data Select, SN74L157 (TI)	3610204-001
U33	NAND Gate, 74LS00	3610084-002
U41	Synchronous 4-Bit Up/Down Counter, 74L193	3610205-001
U42	Same as U41	
U43	Same as U41	
U51	Variable Modulo Counter, 9305 PC (Fairchild)	3610162-001
U52	Same as U5	
U61	Dual Multivibrator, Schmitt Trigger Inputs 74221	3610190-002
U71	Same as U5	
U72	Same as U33	
U81	Multiplexer, 74LS153	3610222-001
XU2	Socket, Integrated Circuit, 14 Pin	1710292-007
XU3	Same as U2	
XU5	Same as U2	
XU21	Socket, Integrated Circuit, 16 Pin	1710292-008
XU22	Same as U21	
XU23	Same as U2	
XU31	Same as U21	
XU32	Same as U21	
XU33	Same as U2	
XU41	Same as U21	
XU42	Same as U21	
XU43	Same as U21	

Table 13-6. Type 8460811-001 Sync Generator Board (A504-1) Parts List (Cont'd)

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 1	
XU51	Same as U2	
XU52	Same as U2	
XU61	Same as U21	
XU71	Same as U2	
XU72	Same as U2	
XU81	Same as U21	
Y1	Crystal, 19,845,000 Hz, ±0.0001%, at 25° C	3510103-002

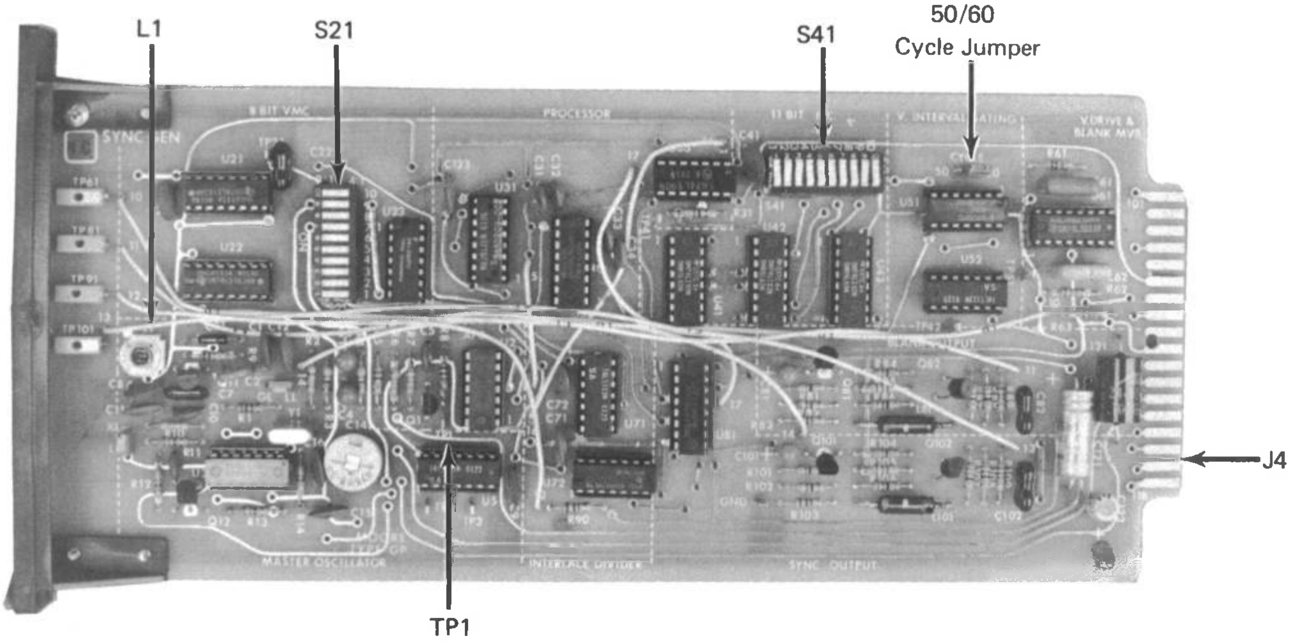


Figure 13-12. Type 8460811-001 Sync Generator Board (A504-1), Location of Components

Table 13-7. Type 8462001-001 Blanking Generator Board (A504-2) Parts List

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 2	
C1	Capacitor, Film, 0.01 μF, ±10%, 100 V	0610157-103
C2	Capacitor, Silver Mica, 3000 pF, ±5%, 500 V	1010007-302
C21	Capacitor, Silver Mica, 3300 pF, ±5%, 500 V	1010007-332
C31	Capacitor, Tantalum, 22 μF, ±20%, 15 V	0510155-005
C51	Capacitor, Tantalum, 3.3 μF, ±10%, 35 V	0510151-117
C52	Capacitor, Tantalum, 4.7 μF, ±20%, 35 V	0510155-006
C71	Capacitor, Silver Mica, 560 pF, ±5%, 300 V	1010006-561
C72	Same as C1	
C81	Capacitor, Film, 0.022 μF, ±10%, 100 V	0610157-223
C91	Capacitor, Electrolytic, 100 μF, -20 +75%, 25 V	0510166-107
C92	Same as C91	
C93	Same as C91	
C94	Capacitor, Electrolytic, 47 μF, -20 +75%, 16 V	0510166-476
MP1	Ejector, Plastic	2010643-001
Q1	Transistor, 2N3638	7210069-001
Q2	Transistor, 2N4123	7210064-008
Q3	Same as Q2	
Q4	Same as Q1	
Q41	Same as Q2	
Q42	Same as Q1	
Q51	Same as Q1	
Q52	Same as Q2	
Q53	Same as Q2	
Q54	Same as Q2	
Q55	Same as Q1	
R1	Resistor, Carbon Film, 1000 Ohm, ±5%, ¼ W	4010025-102
R2	Same as R1	
R3	Resistor, Variable, 500 Ohm, ±20%, 1/5 W	5010147-501
R4	Resistor, Carbon Film, 1500 Ohm, ±5%, ¼ W	4010025-152
R5	Same as R1	
R6	Resistor, Carbon Film, 2700 Ohm, ±5%, ¼ W	4010025-272
R7	Resistor, Variable, 100 Kilohm, ±20%, 1/5 W	5010163-104
R8	Resistor, Carbon Film, 10 Kilohm, ±5%, ¼ W	4010025-103
R9	Resistor, Carbon Film, 150 Kilohm, ±5%, ¼ W	4010025-154
R10	Same as R8	
R11	Same as R8	
R12	Same as R1	
R21	Resistor, Variable, 5000 Ohm, ±10%, 75 W	5010108-502
R22	Resistor, Carbon Film, 3900 Ohm, ±5%, ¼ W	4010025-392
R31	Resistor, Carbon Film, 4700 Ohm, ±5%, ¼ W	4010025-472
R32	Resistor, Carbon Film, 470 Ohms, ±5%, ¼ W	4010025-471
R41	Same as R12	
R42	Same as R32	

Table 13-7. Type 8462001-001 Blanking Generator Board (A504-2) Parts List (Cont'd)

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 2	
R43	Resistor, Carbon Film, 2200 Ohm, ±5%, ¼ W	4010025-222
R44	Resistor, Carbon Film, 75 Ohm, ±5%, ¼ W	4010025-750
R45	Same as R1	
R51	Same as R1	
R52	Same as R1	
R53	Same as R3	
R54	Resistor, Carbon Film, 560 Ohm, ±5%, ¼ W	4010025-561
R55	Same as R1	
R56	Same as R8	
R57	Same as R8	
R58	Same as R8	
R59	Resistor, Composition, 2.7 Megohm, ±5%, ¼ W	4045000-275
R60	Resistor, Carbon Film, 680 Ohm, ±5%, ¼ W	4010025-681
R61	Same as R8	
R62	Resistor, Carbon Film, 22 Kilohm, ±5%, ¼ W	4010025-223
R63	Same as R31	
R64	Resistor, Variable, 5000 Ohm, ±10%, 75 W	5010108-502
R65	Same as R1	
R71	Resistor, Carbon Film, 220 Kilohm, ±5%, ¼ W	4010025-224
R72	Same as R63	
R73	Resistor, Variable, 100 Kilohm, ±20%, 1/5 W	5010147-104
R81	Resistor, Variable, 100 Kilohm, ±10%, 75 W	5010108-104
R82	Resistor, Carbon Film, 68 Kilohm, ±5%, ¼ W	4010025-683
R91	Resistor, Carbon Film, 22 Ohm, ±5%, ¼ W	4010025-220
R92	Resistor, Carbon Film, 820 Ohm, ±5%, ¼ W	4010025-821
R93	Resistor, Carbon Film, 150 Ohm, ±5%, ¼ W	4010025-151
TP1	Test Point	1710250-004
TP2	Test Point	1710280-001
TP41	Same as TP1	
TP51	Same as TP1	
TP52	Same as TP2	
TP53	Same as TP2	
TP71	Same as TP2	
U21	Hex Buffer Inverter, CD4049 (RCA)	3610167-001
U22	Quad 2 Input NOR Gate, CD4001-UBE (RCA)	3610151-001
U71	Same as U22	
XU21	Socket, Integrated Circuit, 16 Pin	1710292-008
XU22	Socket, Integrated Circuit, 14 Pin	1710292-007
XU71	Same as XU22	

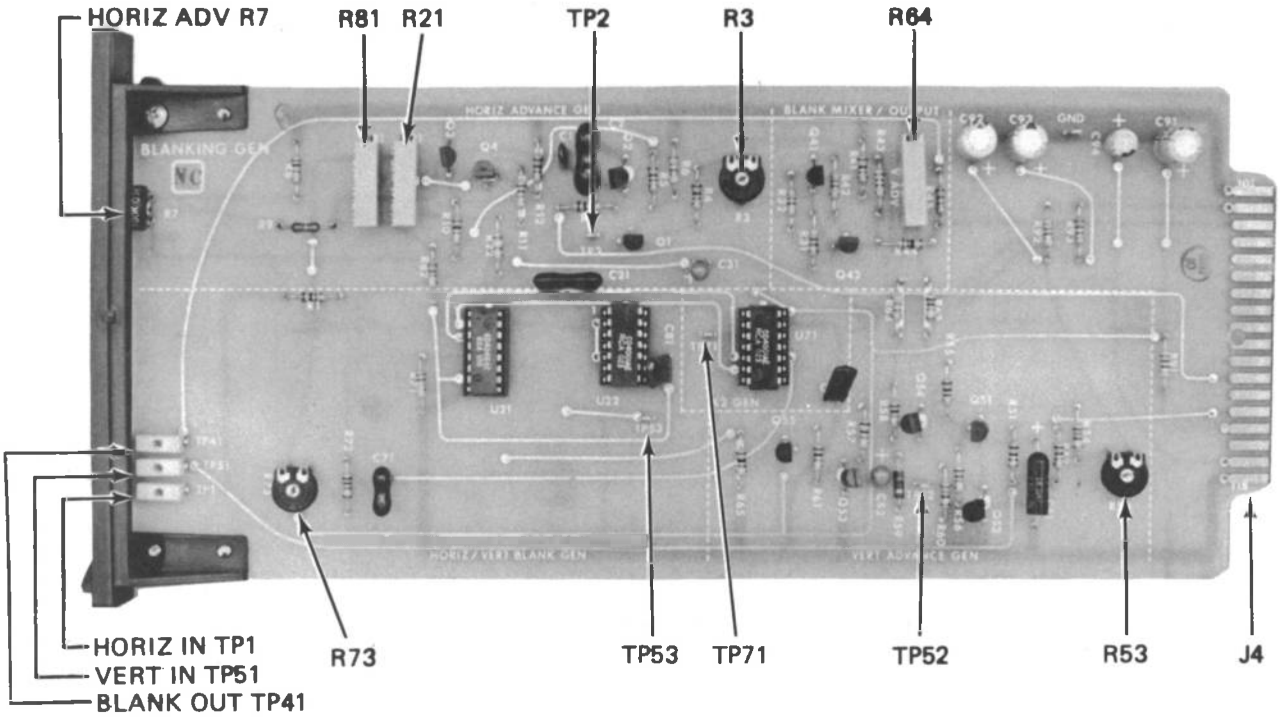


Figure 13-13. Type 8462001-001 Blanking Generator Board (A504-2), Location of Components

Table 13-8. Type 8460502-001 Power Supply Assembly (A506) Parts List

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 3	
A1	Power Supply Board	8460502-001
CR13	Diode, LED Indicator (Red) 5110F1 (Daylight)	1710342-001
CR14	Same as CR13	
J10	Receptacle, AC (Belden 17252)	1710338-001
P73	Connector, 24 Pin	1310315-248
	Key	1310315-151
S1	Switch, Power DPDT 9221	6110119-002
S2	Switch, Toggle	6110050-017
S3	Switch, AC Slide	6110121-001
T1	Transformer, Power	8460510-001
	P72 Connector, 12 Pin	1310300-012
	Key	1310300-151
W1	Cable Assembly, 16 Pin	7610116-001
W2	Line Cord, 3 Conductive, Detachable	7610117-001

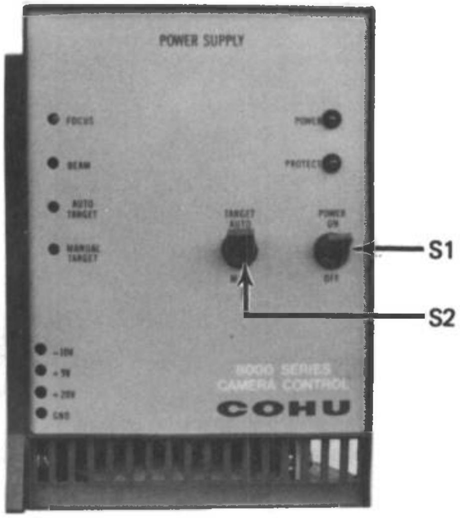


Figure 13-14. Type 8460502-001 Power Supply Assembly (A506), Front View, Location of Components

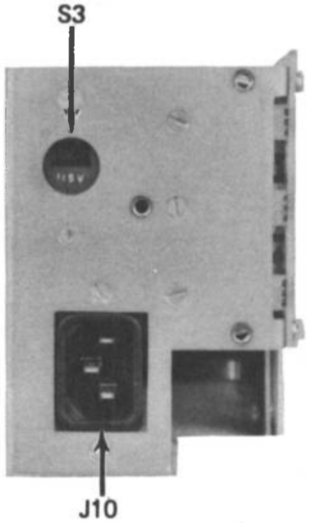


Figure 13-15. Type 8460502-001 Power Supply Assembly (A506), Rear View, Location of Components

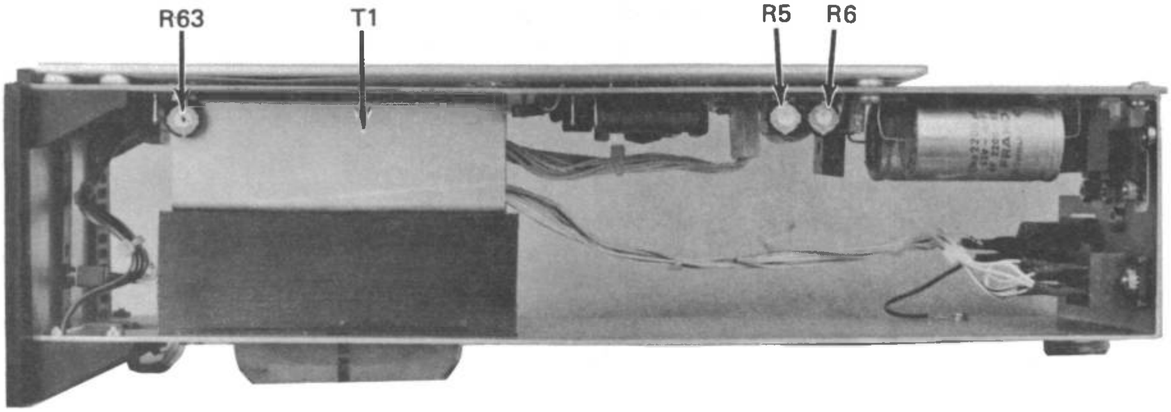


Figure 13-16. Type 8460502-001 Power Supply Assembly (A506), Top View, Location of Components

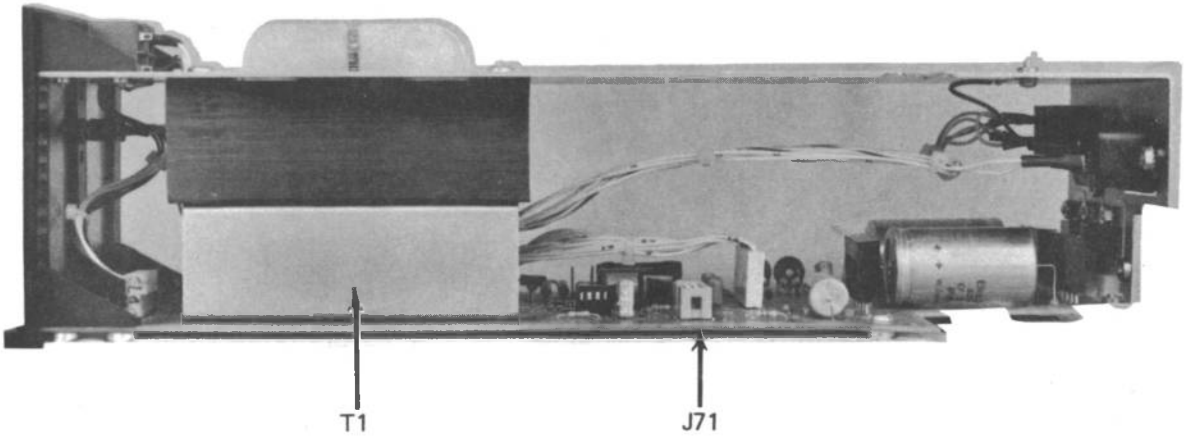


Figure 13-17. Type 8460502-001 Power Supply Assembly (A506), Bottom View, Location of Components

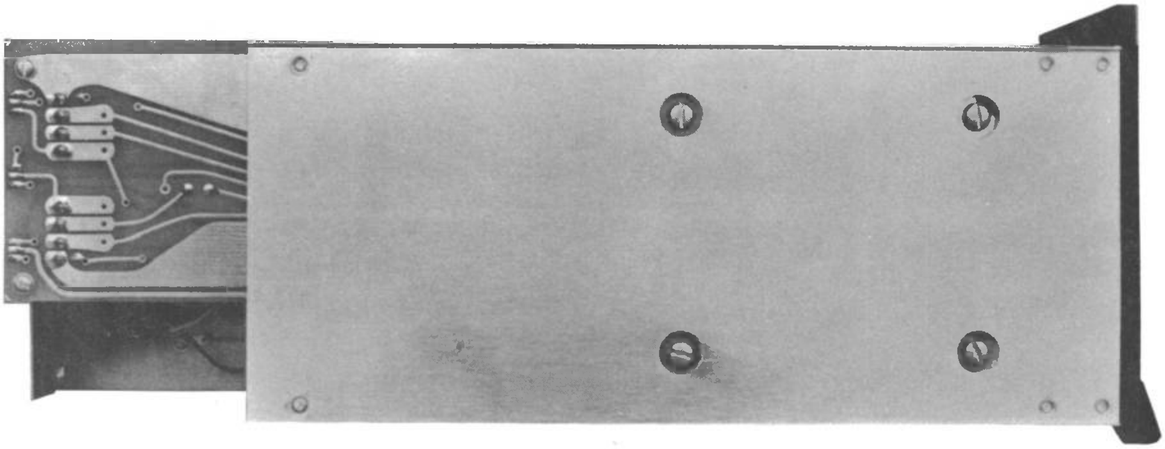


Figure 13-18. Type 8460502-001 Power Supply Assembly (A506), Right View, Location of Components

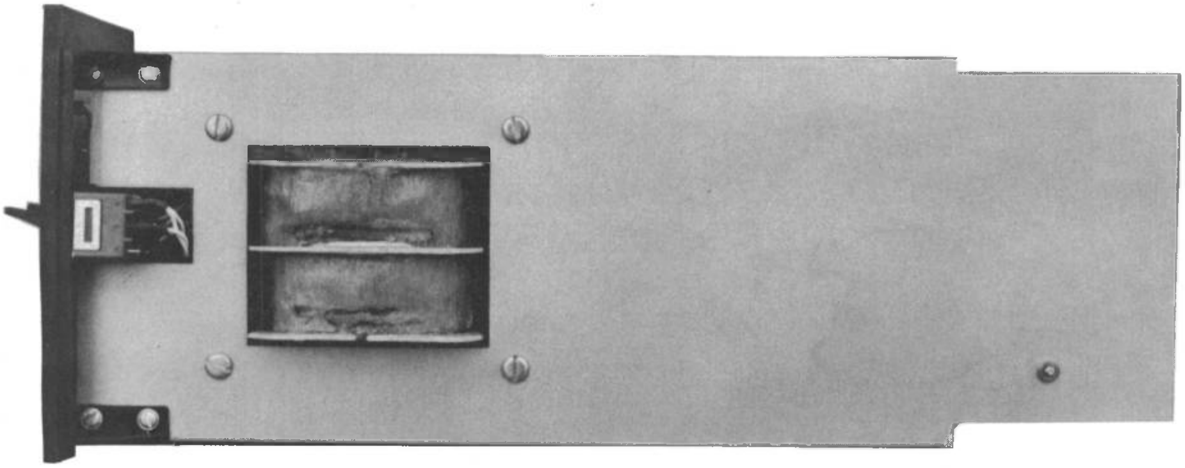


Figure 13-19. Type 8460502-001 Power Supply Assembly (A506), Left View, Location of Components

Table 13-9. Type 8460501-001 Power Supply Board (A506A1) Parts List

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 2	
C1	Capacitor, Electrolytic, 2200 μF, -10 +100%, 63 V	0510160-039
C3	Capacitor, Electrolytic, 22 μF, -20 +75%, 25 V	0510166-226
C7	Same as C1	
C10	Same as C3	
C11	Same as C3	
C12	Capacitor, Electrolytic, 2.2 μF, -10 +75%, 450 V	0510148-902
C13	Same as C12	
C14	Capacitor, Ceramic Disk, 0.02 pF, ±20%, 500 V	0401058
C15	Capacitor, Electrolytic, 1000 μF, -10 +100%, 16 V	0510160-012
C17	Capacitor, Electrolytic, 10 μF, -20 +75%, 50 V	0510166-106
C20	Same as C17	
C21	Capacitor, Film, 0.33 μF, ±20%, 100 V	0610136-334
C22	Capacitor, Film, 0.1 μF, ±10%, 100 V	0610157-104
CR1	Diode, Bridge Rectifier, MDA970-A2 (Motorola)	3510087-001
CR2	Same as CR1	
CR3	Same as CR1	
CR4	Diode, 1N4007	3510018-016
CR5	Same as CR4	
CR6	Same as CR4	
CR7	Same as CR4	
CR8	Diode, Zener, 100 V, IN5378B	3510036-053
CR9	Same as CR8	
CR10	Same as CR8	
CR11	Same as CR8	
CR12	Diode, 1N4148	3510042-029
J71	Jack, 16 Contacts	1310326-001
Q1	Transistor, 2N5551	7210072-007
R26	Resistor, Power, 22 Kilohm, ±5%, 5 W	5110045-001
R27	Resistor, Composition, 3.3 Megohm, ±5%, ½ W	0310030-335
R28	Same as R27	
R30	Resistor, Variable, 1 Megohm, ±20%, .2 W	5010163-105
R31	Resistor, Carbon Film, 180 Ohm, ±5%, ¼ W	4010025-181
R38	Resistor, Carbon Film, 120 Ohm, ±5%, ¼ W	4010025-121
R39	Resistor, Carbon Film, 1600 Ohm, ±5%, ¼ W	4010025-162
R40	Resistor, Variable, 500 Ohm, ±20%, 1/5 W	5010163-501
R41	Same as R38	
R42	Resistor, Carbon Film, 620 Ohm, ±5%, ¼ W	4010025-621
R43	Same as R40	
R45	Resistor, Carbon Film, 470 Ohm, ±5%, ¼ W	4010025-471
R51	Resistor, Carbon Film, 270 Kilohm, ±5%, ¼ W	4010025-274
R52	Resistor, Variable, 10 Kilohm, ±20%, ¼ W	5010163-103
R53	Resistor, Carbon Film, 470 Kilohm, ±5%, ¼ W	4010025-474

Table 13-9. Type 8460501-001 Power Supply Board (A506A1) Parts List (Cont'd)

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 2	
R54	Resistor, Carbon Film, 100 Kilohm, ±5%, ¼ W	4010025-104
R55	Resistor, Carbon Film, 47 Kilohm, ±5%, ¼ W	4010025-473
R56	Resistor, Composition, 1 Megohm, ±5%, ½ W	0310030-105
R57	Resistor, Composition, 22 Megohm, ±5%, ¼ W	4045000-226
R58	Resistor, Carbon Film, 12 Kilohm, ±5%, ¼ W	4010025-123
R59	Same as R51	
R60	Same as R27	
R61	Same as R30	
R62	Same as R52	
R63	Same as R53	
TP1	Test Point	1710250-004
TP2	Same as TP1	
TP3	Same as TP1	
TP4	Same as TP1	
TP5	Test Point	1710280-001
TP6	Same as TP5	
TP7	Same as TP5	
U1	Regulator, Adjustable, LM337T (National)	3610281-001
U2	Operational Amplifier, LM741N (Raytheon)	3610108-001
U3	Regulator, Adjustable, LM317T (National)	3610245-002
U4	Voltage Regulator, 5 V, LM-340T-05 (National)	3610144-005
XU1	Socket, Transistor	1710340-001
XU2	Socket, Integrated Circuit, 8 Pin	1710292-004
XU3	Same as XU1	
XU4	Same as XU1	

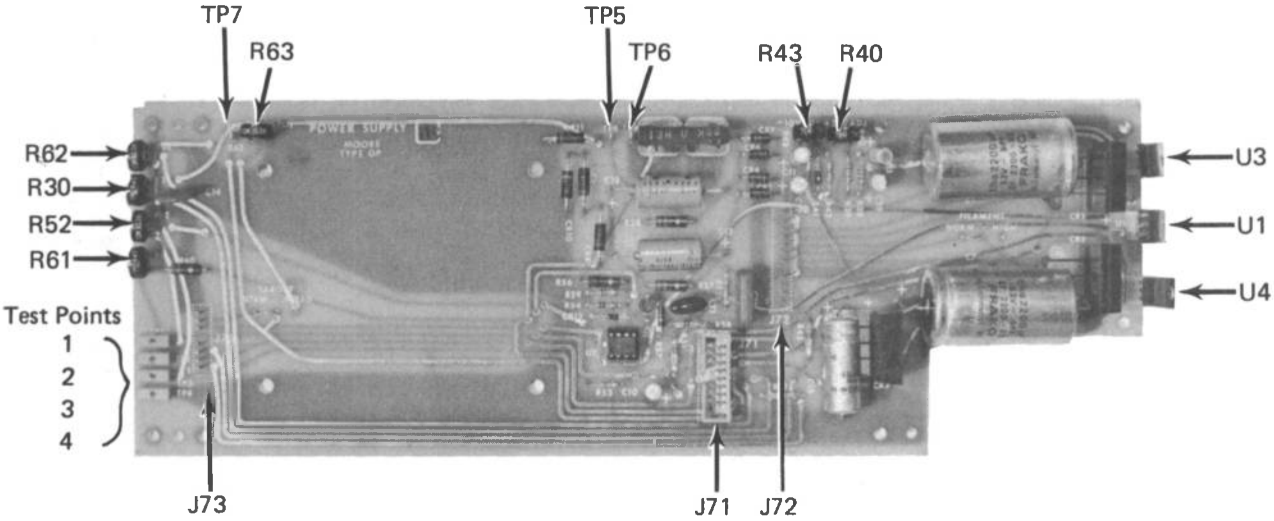


Figure 13-20. Type 8460501-001 Power Supply Board (A506A1), Location of Components

Table 13-10. Type 8461921-001 Interconnect Board (A507) Parts List

REF DES	DESCRIPTION	COHU PART NUMBER
	ISSUE 2	
J1	Connector, Card Edge,	1310325-036
	Key	1310325-101
J2	Same as J1	
J3	Same as J1	
J4	Same as J1	
J5	Same as J1	
J6	Pin, Circuit Board Mounting	1310321-002

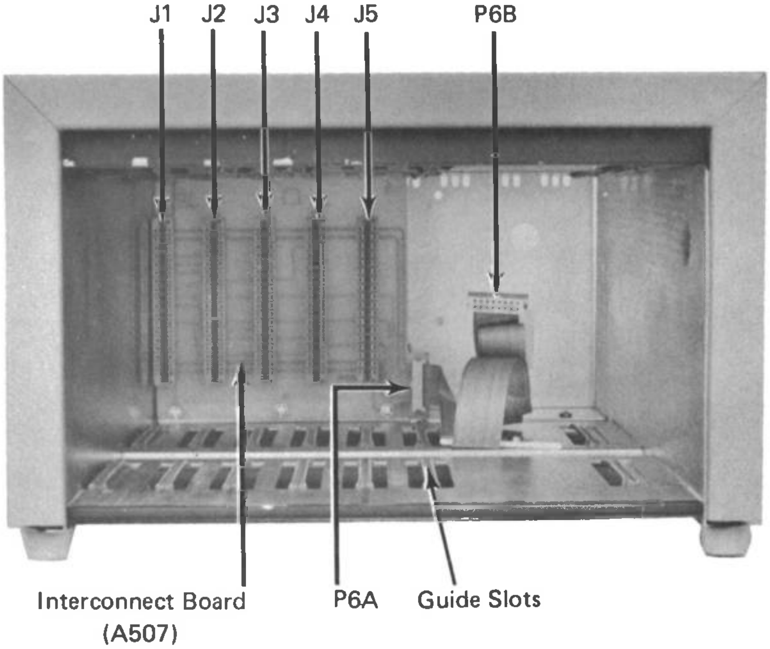


Figure 13-21. Type 84619121-001 Interconnection Board (A507), Location of Components

PART TWO – CCU

SECTION XIV
SCHEMATIC DIAGRAMS

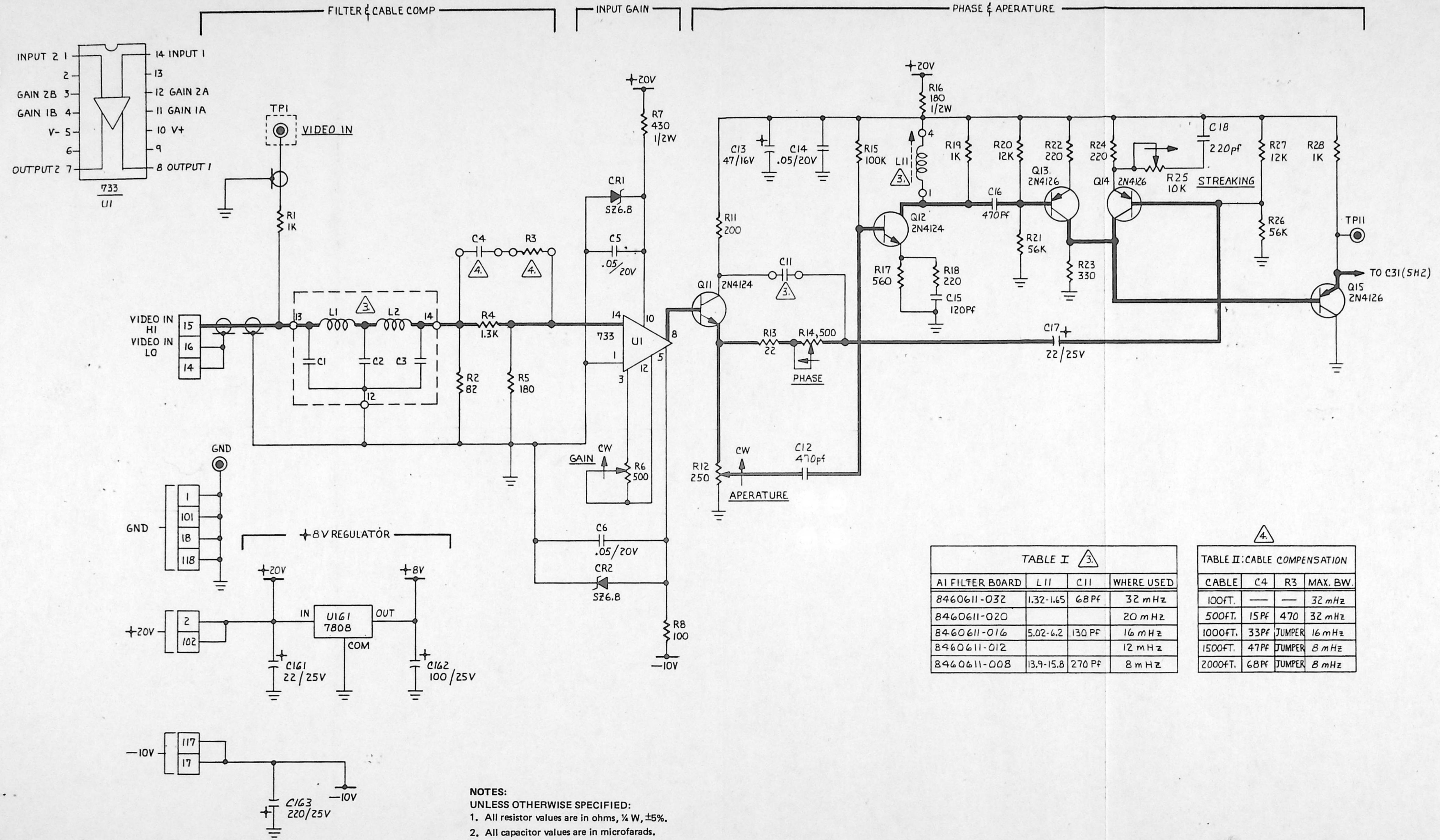


TABLE I 3.			
A1 FILTER BOARD	L11	C11	WHERE USED
8460611-032	1.32-1.65	68 Pf	32 mHz
8460611-020			20 mHz
8460611-016	5.02-6.2	130 PF	16 mHz
8460611-012			12 mHz
8460611-008	13.9-15.8	270 PF	8 mHz

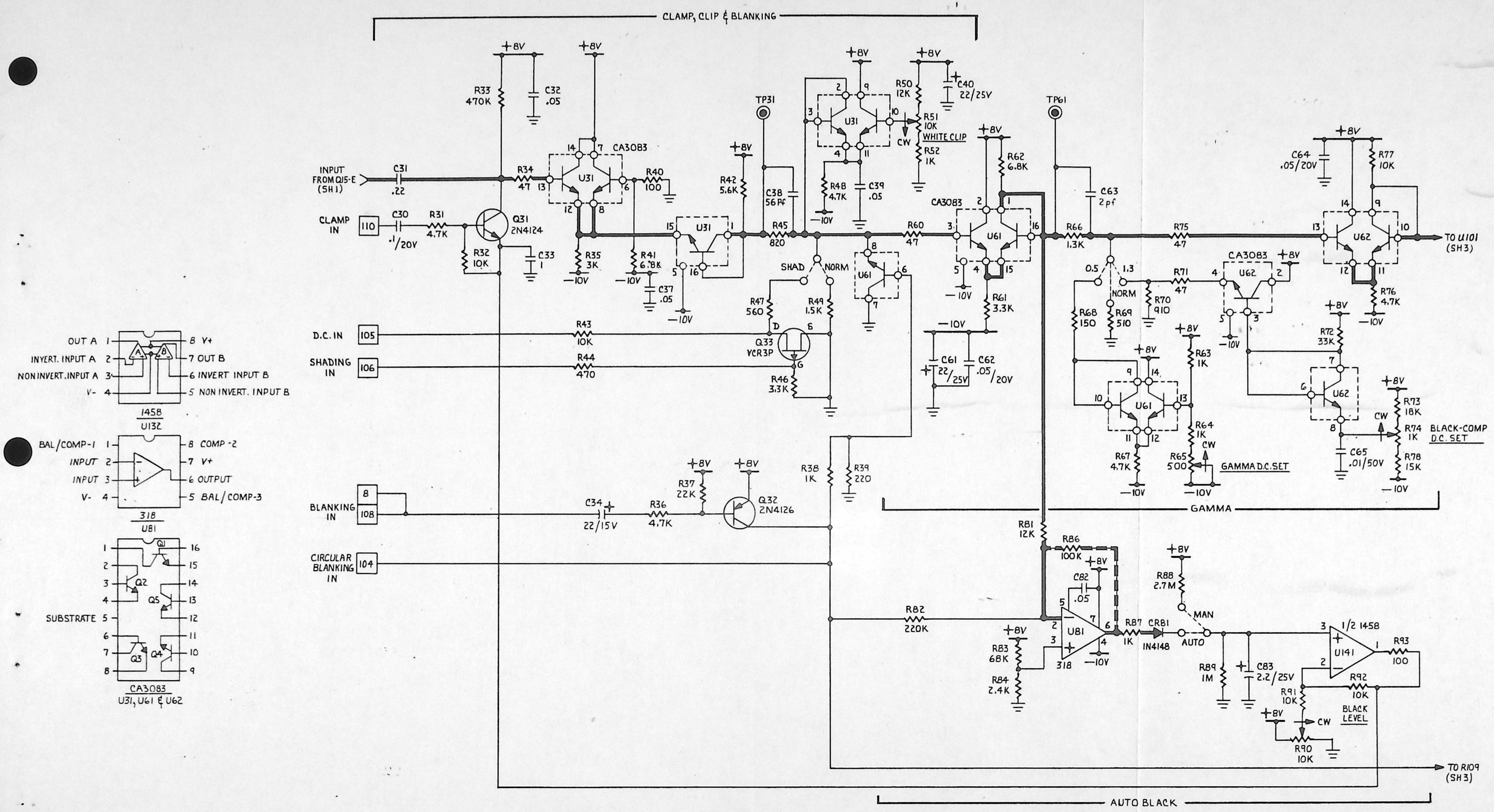
4.

TABLE II: CABLE COMPENSATION			
CABLE	C4	R3	MAX. BW.
100FT.	—	—	32 mHz
500FT.	15Pf	470	32 mHz
1000FT.	33Pf	JUMPER	16 mHz
1500FT.	47Pf	JUMPER	8 mHz
2000FT.	68Pf	JUMPER	8 mHz

NOTES:
UNLESS OTHERWISE SPECIFIED:
1. All resistor values are in ohms, ¼ W, ±5%.
2. All capacitor values are in microfarads.
3. See Table 1.
4. See Table II.

(from dwg D8460600A)

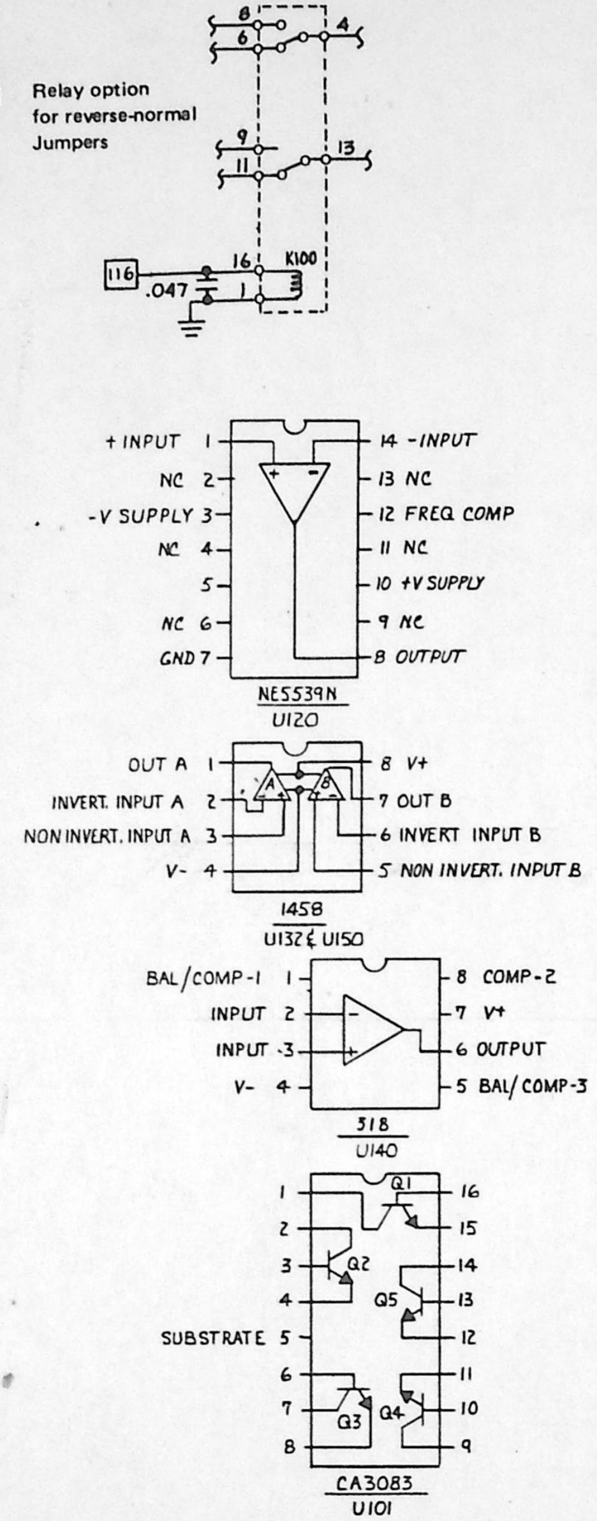
Figure 14-1. Type 8460601-001 Video Board (A501), Schematic Diagram (Sheet 1 of 3)

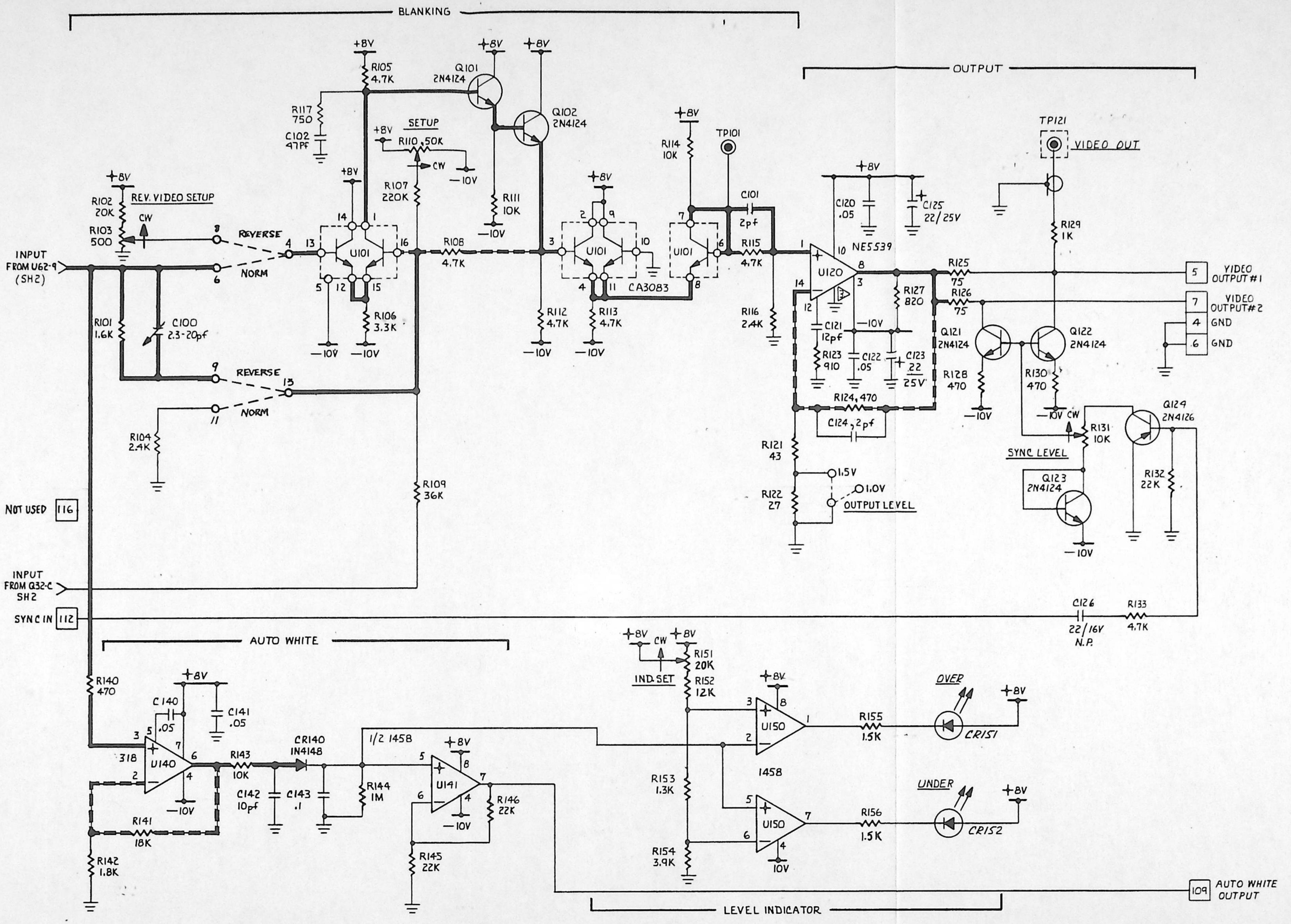


NOTES:
UNLESS OTHERWISE SPECIFIED:
1. All resistor values are in ohms, ¼ W, ±5%.
2. All capacitor values are in microfarads.

(from dwg D8460600A)

Figure 14-1. Type 8460601-001 Video Board (A501), Schematic Diagram (Sheet 2 of 3)

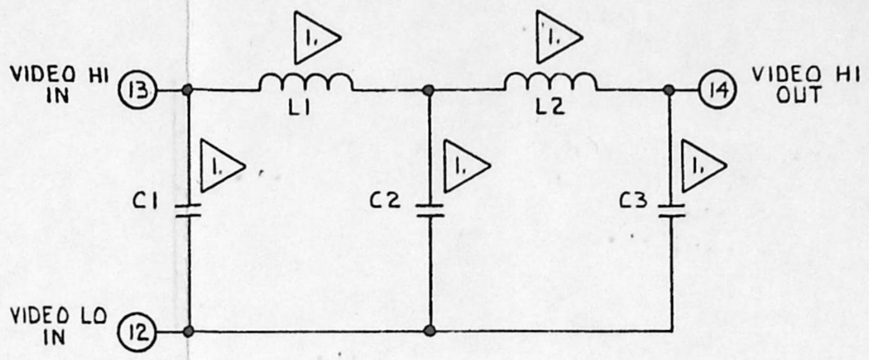




NOTES:
UNLESS OTHERWISE SPECIFIED:
1. All resistor values are in ohms, ¼ W, ±5%.
2. All capacitor values are in microfarads.
③ U120–2, 4, 6, 7, 9, 11 & 13 are connected to GND.

(from dwg D8460600A)

Figure 14-1. Type 8460601 Video Board (A501), Schematic Diagram (Sheet 3 of 3)



COMPONENT VALUE TABLE					
ASSY	-008 8 MHZ	-012 12 MHZ	-016 16 MHZ	-020 20 MHZ	-032 32 MHZ
L1	2.2 µH	1.5 µH	1.2 µH	.82 µH	.56 µH
L2	2.2 µH	1.5 µH	1.2 µH	.82 µH	.56 µH
C1	200 PF	120 PF	100 PF	75 PF	47 PF
C2	390 PF	270 PF	200 PF	160 PF	100 PF
C3	200 PF	120 PF	100 PF	75 PF	100 PF

NOTES:
UNLESS OTHERWISE SPECIFIED:

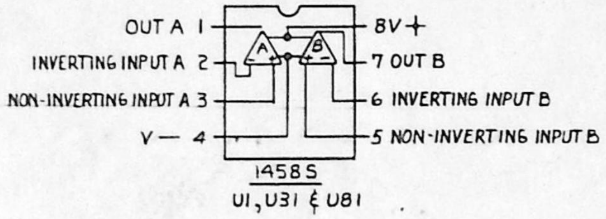
1. For 8, 12, 16, 20 or 32 MHz operation see component value table.

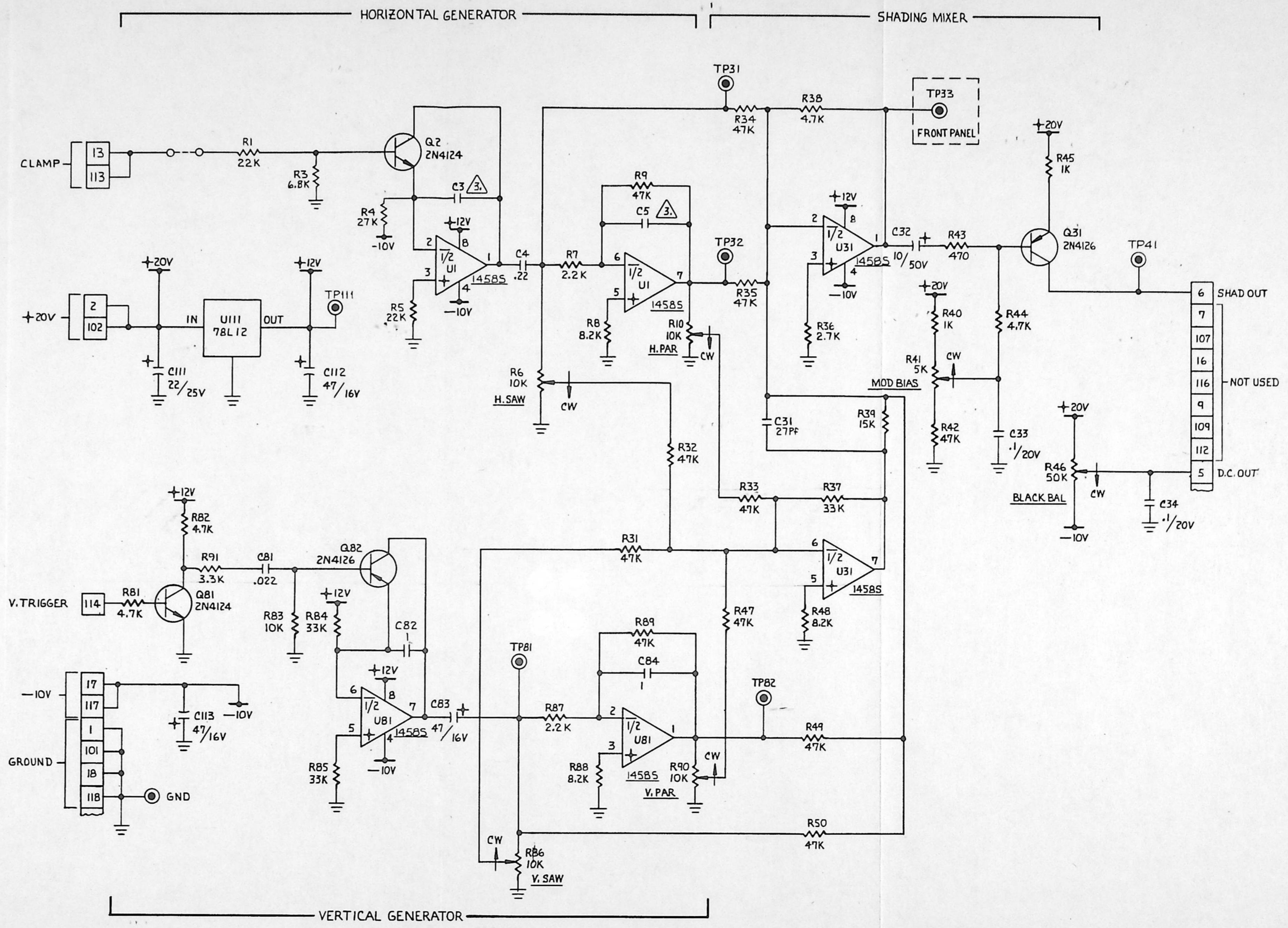
(from dwg B8460610)

Figure 14-2. Type 8460611-008/-012/-016/-020/-032 Filter Board (A501A1) Schematic Diagram

TABLE I △3

SCAN RATE	COMPONENT	VALUE
525 625	C3, C5	3300 pf
729	↕	2400 pf
875 945 1023	↕	1800 pf
1125 1225	C3, C5	1500 pf

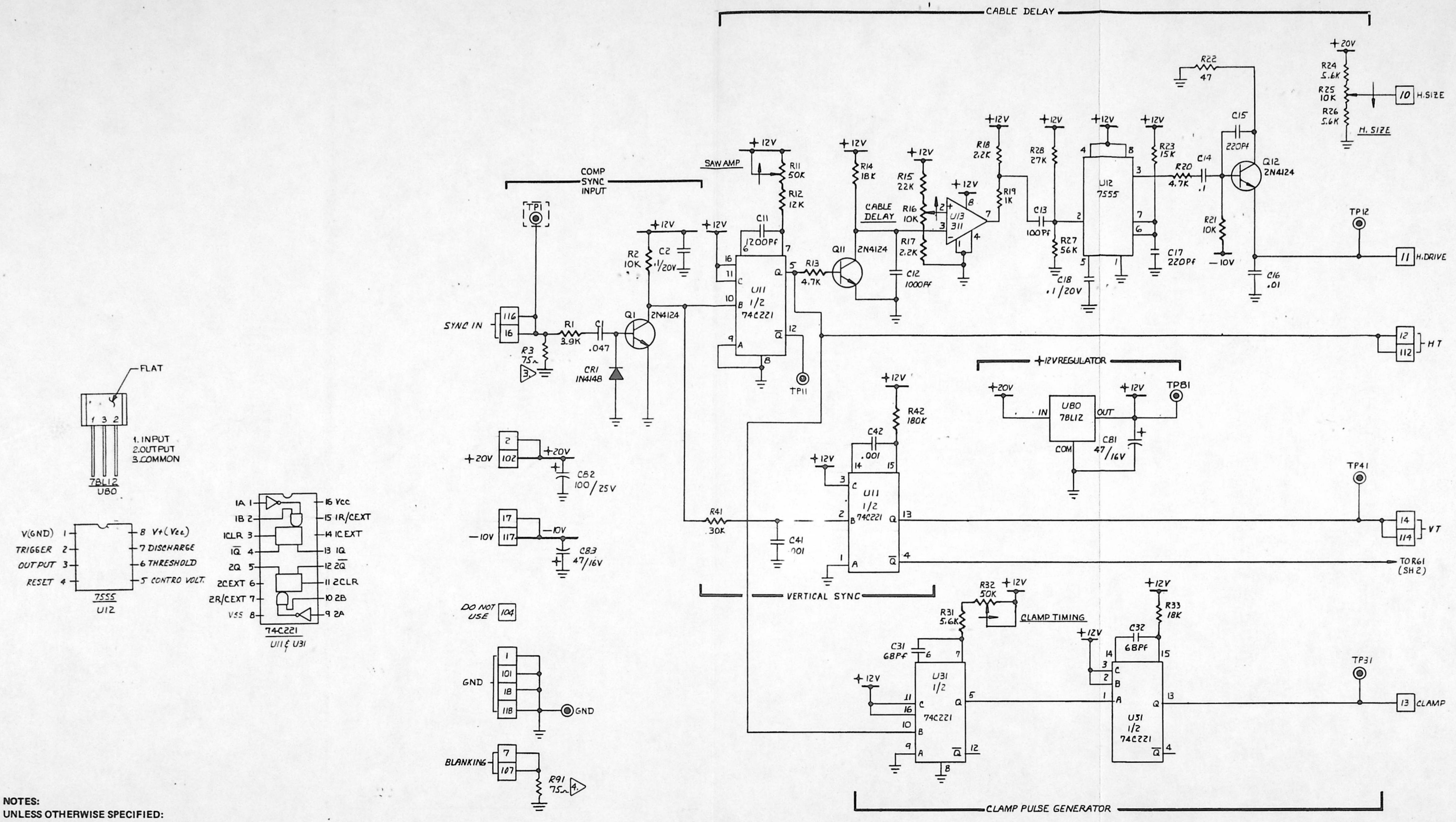




(from dwg D8460700A)

Figure 14-3. Type 8460701-001 Shading Board (A502), Schematic Diagram

NOTES:
UNLESS OTHERWISE SPECIFIED:
1. All resistor values are in ohms, ¼ W, ±5%.
2. All capacitor values are in microfarads.
△3. Values determined by scan rate. See Table I.



NOTES:
UNLESS OTHERWISE SPECIFIED:

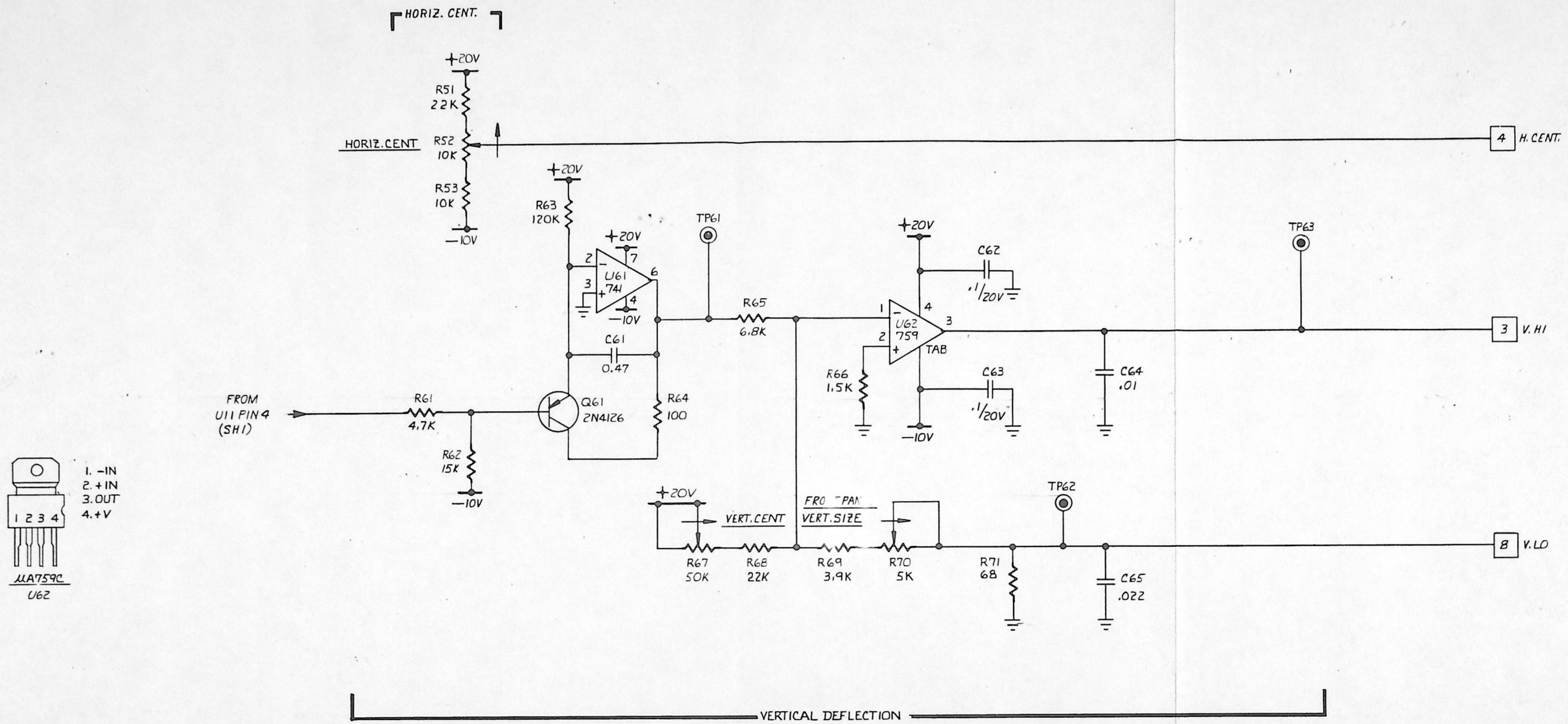
1. All resistor values are in ohms, ¼ W, ±5%.
2. All capacitor values are in microfarads.

3. Remove for loop-thru.

4. Remove for loop-thru or when blanking board is used.

(from dwg D8460400B)

Figure 14-4. Type 8460401-001 Deflection Board (A503), Schematic Diagram (Sheet 1 of 2)

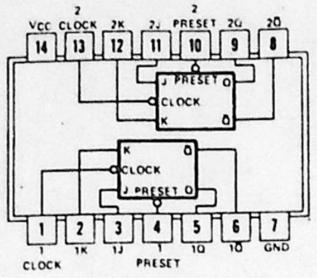


NOTES:
UNLESS OTHERWISE SPECIFIED:

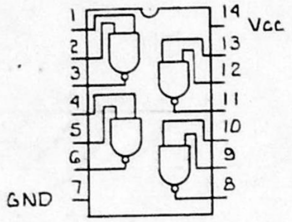
1. All resistor values are in ohms, ¼ W, ±5%.
2. All capacitor values are in microfarads.

(from dwg D8460400B)

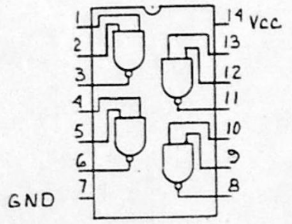
Figure 14-4. Type 8460401-001 Deflection Board (A503), Schematic Diagram (Sheet 2 of 2)



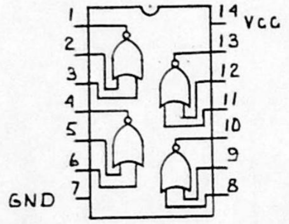
U5, U52, U71
74LS113



U3
74LS00



U33 & U72
74LS00



U2
74LS02

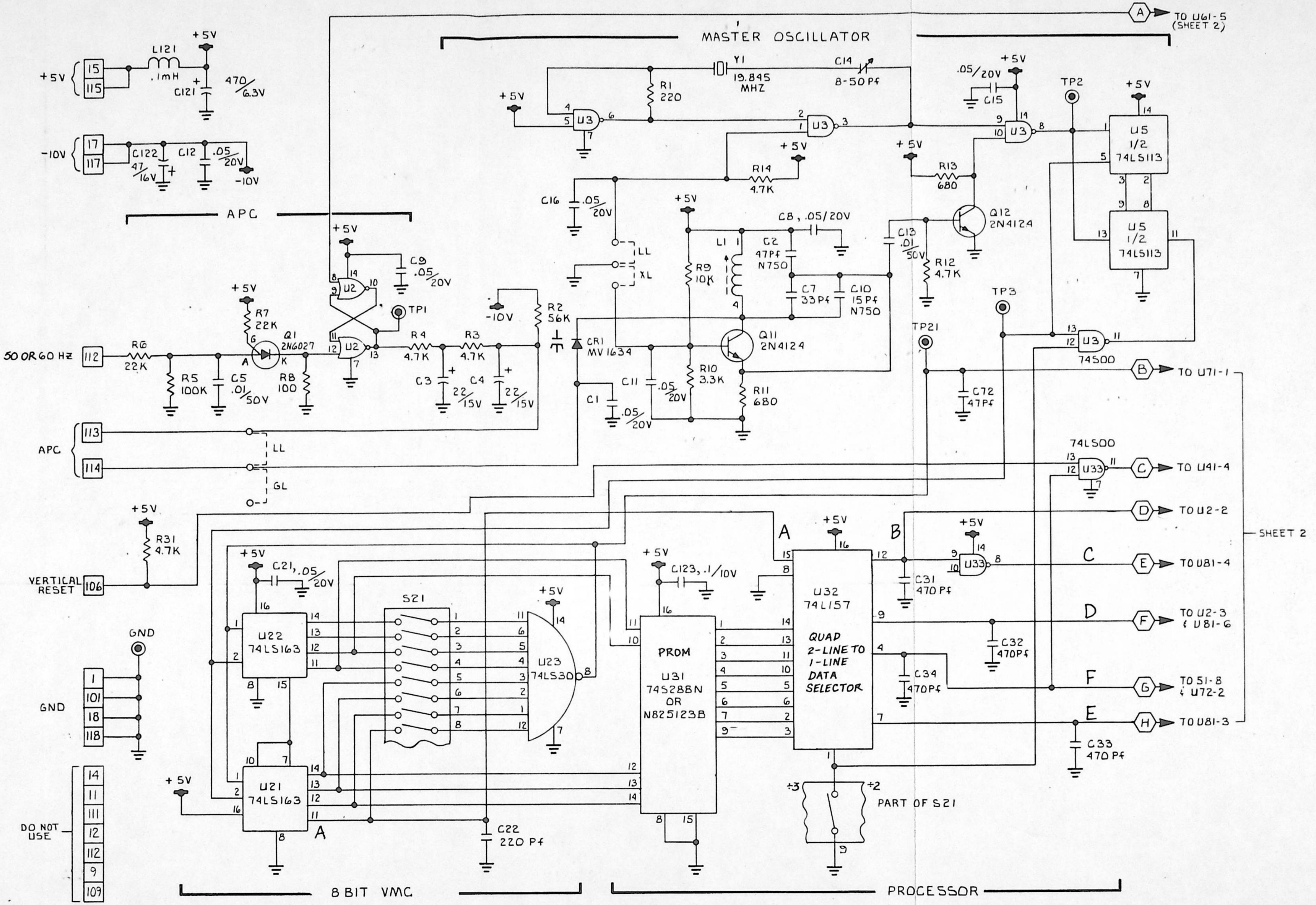
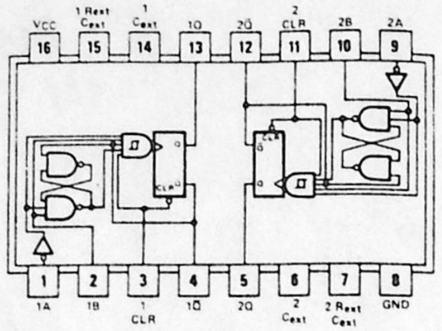
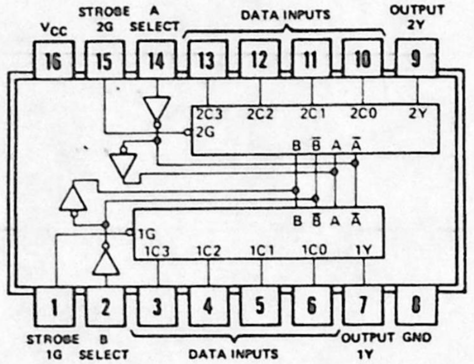


Figure 14-5. Type 8460811-001 Sync Generator Board (A504-1), Schematic Diagram (Sheet 1 of 2)

(from dwg D8460810A)



U61
74LS221



U81
74LS153

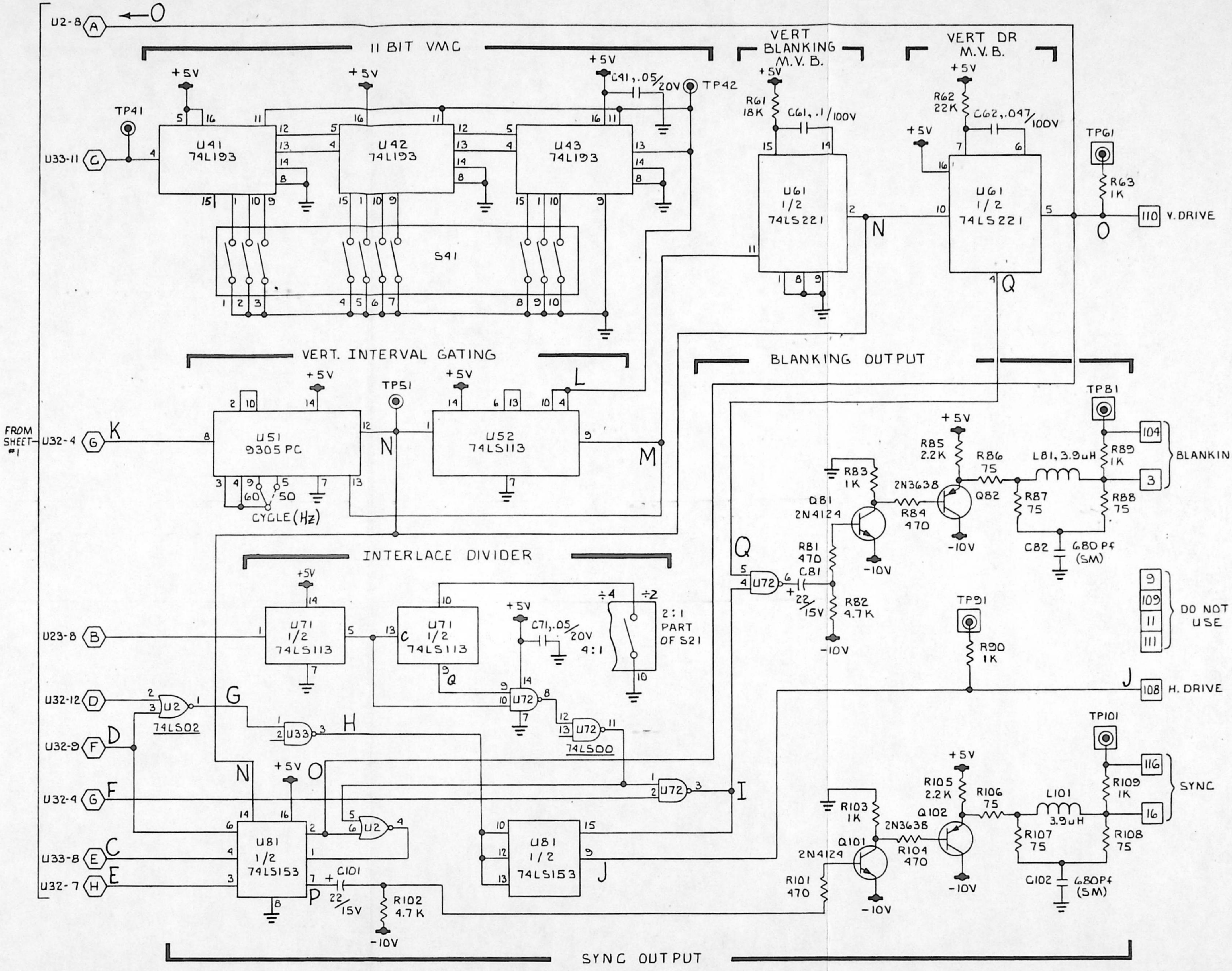
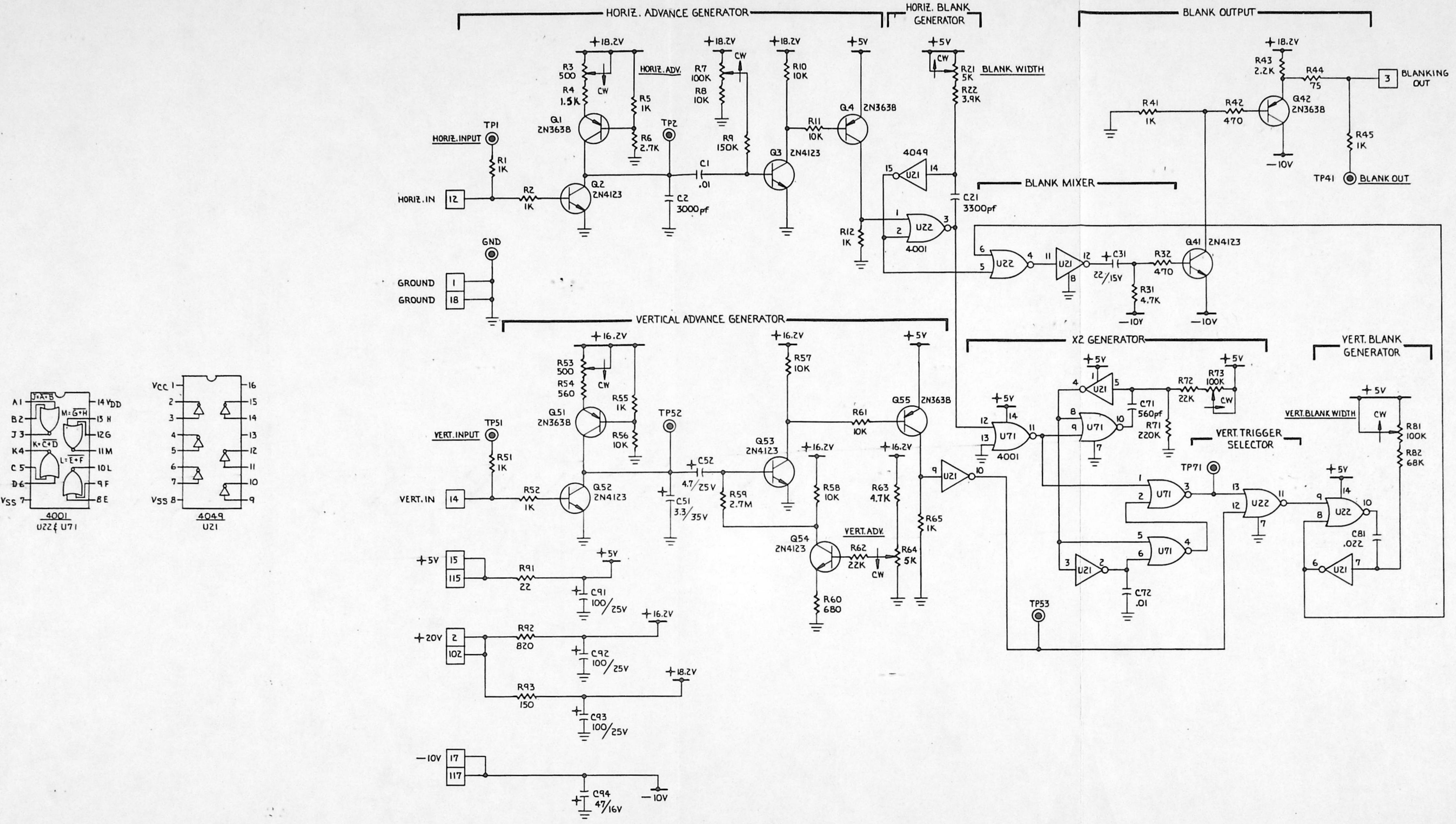


Figure 14-5. Type 8460811-001 Sync Generator Board (A504-1), Schematic Diagram (Sheet 2 of 2)

(from dwg D8460810A)

NOTES:
UNLESS OTHERWISE SPECIFIED:
1. All resistor values are in ohms, ¼ W, ±5%.
2. All capacitor values are in microfarads.
3. Letters A through R designate waveforms of figures 11-6 and 11-7.



NOTES:
UNLESS OTHERWISE SPECIFIED:
1. All resistor values are in ohms, ¼ W, ±5%.
2. All capacitor values are in microfarads.

(from dwg D8462000A)

Figure 14-6. Type 8462001-001 Blanking Generator Board (A504-2), Schematic Diagram

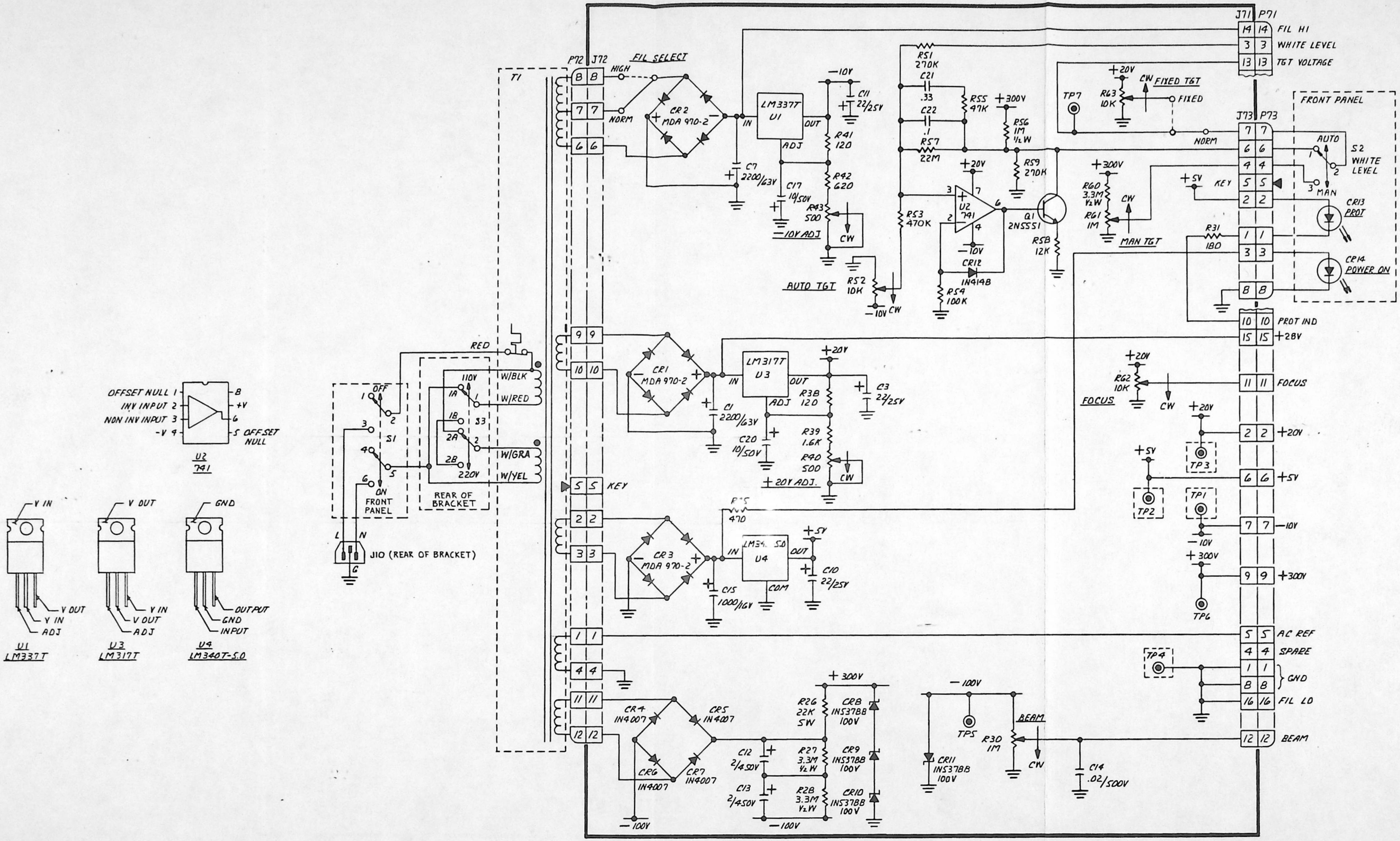
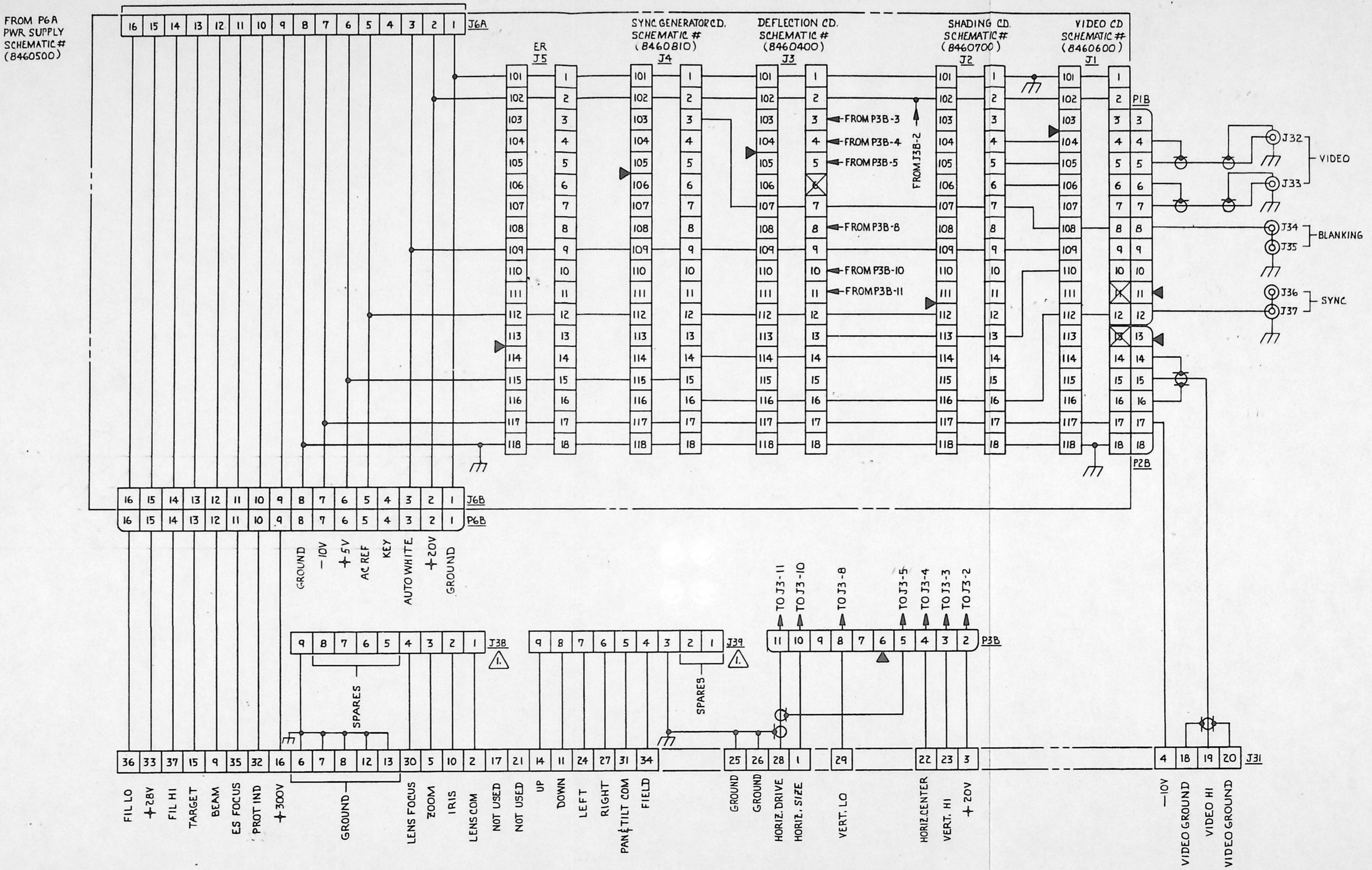


Figure 14-7. Type 8460502-001 Power Supply Board (A506A1) Schematic Diagram

(from dwg D8460500B)

NOTES:
UNLESS OTHERWISE SPECIFIED:
1. All resistor values are in ohms, ¼ W, ±5%.
2. All capacitor values are in microfarads.

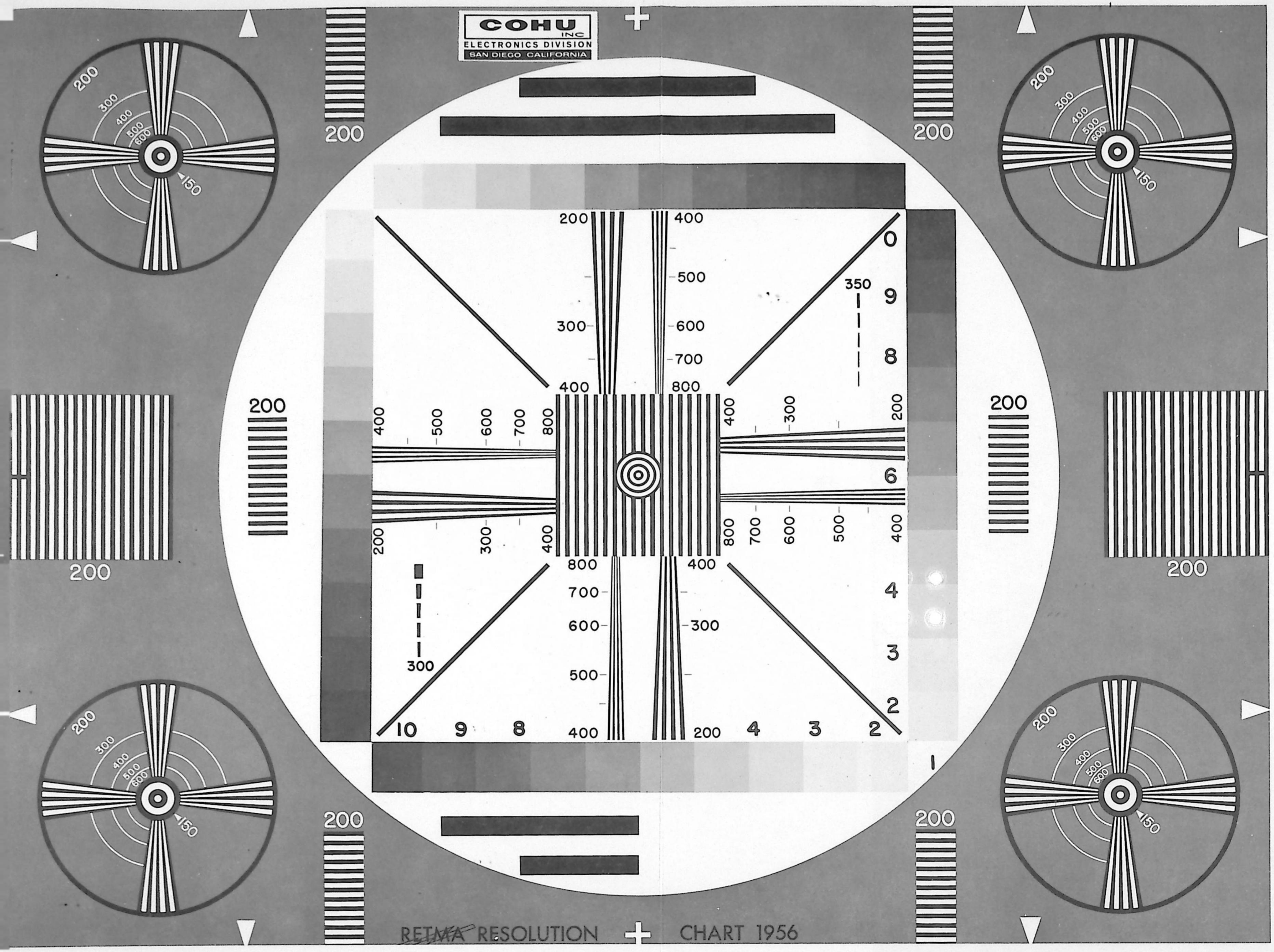


NOTES:
UNLESS OTHERWISE SPECIFIED:

1. J38 (Lens Connector) & J39 (P/T Connector) are optional on rear panel.

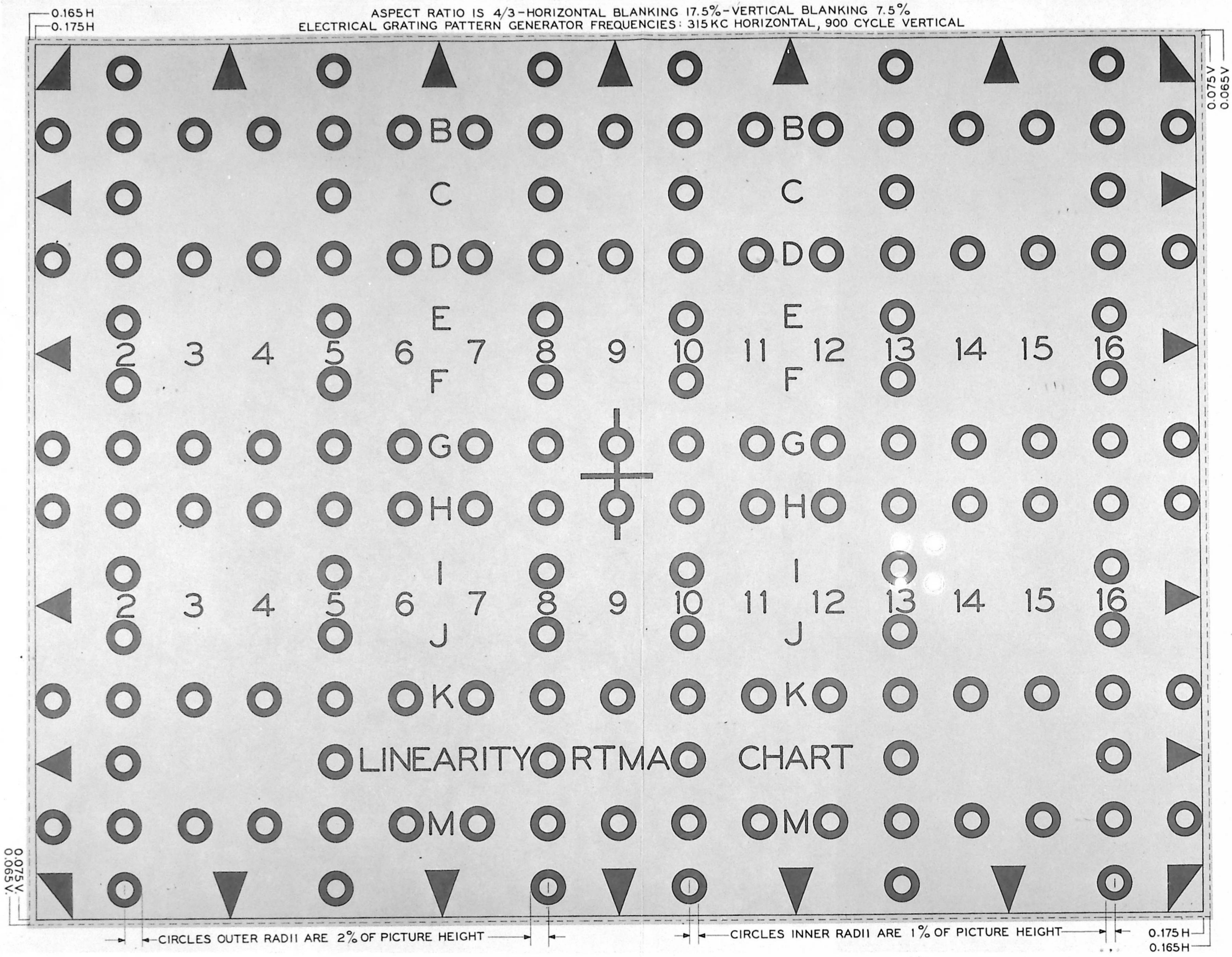
(from dwg D8461900A)

Figure 14-8. Model 8000 CCU, Schematic Diagram


COHU
INC
ELECTRONICS DIVISION
SAN DIEGO CALIFORNIA
RETMA RESOLUTION CHART 1956

Code No. 6-358

ASPECT RATIO IS 4/3-HORIZONTAL BLANKING 17.5%-VERTICAL BLANKING 7.5%
ELECTRICAL GRATING PATTERN GENERATOR FREQUENCIES: 315 KC HORIZONTAL, 900 CYCLE VERTICAL



CIRCLES OUTER RADII ARE 2% OF PICTURE HEIGHT

CIRCLES INNER RADII ARE 1% OF PICTURE HEIGHT

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This warranty does not extend to COHU equipment subjected to misuse, accident, neglect or improper application, nor repaired or altered by other than COHU or those authorized by COHU in writing. Television image pickup tubes are warranted by the original manufacturer.

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